# Engineering News

Vol. 67. 505 Pearl Street, New York No. 3

## Tests of a 2880-kw. Rebuilt Hydro-Electric Unit at the Kern River Plant of the Pacific Light and Power Company*

By G. J. Henry† and J. H. Hansen†

The Old Plant—The Kern River power plant (also known as the "Borel" station) of the Pacific Light & Power Co., of Los Angeles, has many interesting features and its history as a hydraulic development is an engaging one.

The water for driving the turbines is taken from the Kern River and carried through a concrete-lined canal 12 miles long to a forebay located directly above the power house, as shown in Fig. 1. In this way a drop of 260 ft. is created and the water is taken from the forebay to the turbines through five 5-ft. steel pipes, each 500 ft. long.

The original installation comprised five Girard-type impulse turbines connected to five 2500-kw. generators. The wheels were mounted overhung on the 16-in. shaft extension of the generators and the speed was 231 r.p.m. As the power house is located on a bank about 25 ft. above the river, the wheels were provided with draft tubes and by means of an air inlet on the casing, regulated through a float valve in the tailrace, the water in the draft tube was to be kept a certain distance below the wheels.

After about four years' operation, it was decided to take these turbines out, as they did not have the desired efficiency. Operation proved unsatisfactory from the start and many changes were made in the structural features in an effort to better the efficiency and reliability, but without much success.

New Equipment—At about this time the problem was presented to the writers' company. After investigation, a Francis type of turbine was recommended for the conditions there involved, although the generator speed of 231 r.p.m. was quite low for this type of wheel. The use of a tangential impulse wheel was opposed as entirely unsuited to the conditions. However, the Pacific Light & Power Co. placed a contract with another builder for a tangential type of unit, based on guarantees of performance, which in the writers' opinion could never be met by this type of unit. As built and tested, this unit consisted of two wheels, each supplied with two needle nozzles set in a pit some 9 ft. below the floor line, in order to reduce the draft head to a minimum and to increase the pressure head. It is our belief that only inferior results have so far been obtained, in spite of several changes in the unit, including the abandonment of draft.

Fig. 1. The Kern River Station of the Pacific Light & Power Co.

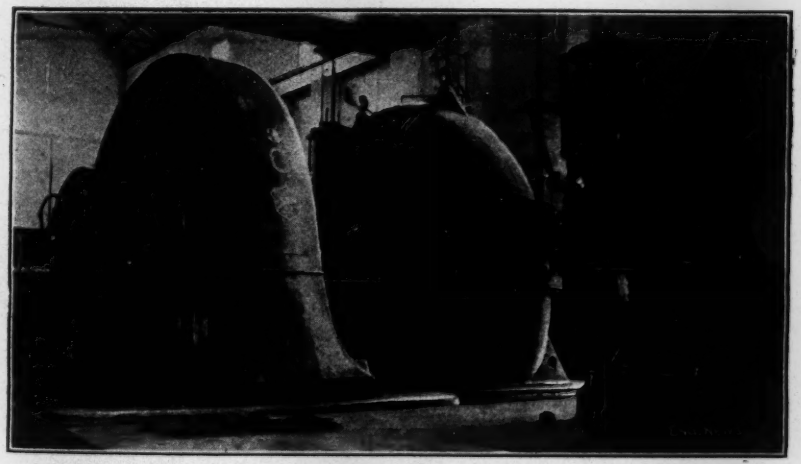

Fig. 2. Pelton-Francis Turbine in the Place of a Girard Type; Borel Station

The writers' company was awarded the contract for the four other units, the purchaser taking the precaution to have the first unit built and installed and very thoroughly tested, in compliance with guarantees, before authorizing the manufacture of the other three.

In the design of these Francis-type turbines a large diameter (84 in.) runner was necessary, making the surface friction and runner-casing clearance critical. The large diameter of runner necessitated a large diameter of spiral casing; this stands 16½ ft. high and weighs 30,000 lb. It is parted horizontally.

The flow of water to the turbine may be controlled by a 42-in. hydraulically operated gate valve. The water passage to the runner is under the control of 32 cast-steel wicket gates or guide vanes,

*From a paper read before the San Francisco Section, American Institute of Electrical Engineers, Nov. 1, 1911.

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FIG. 3. TAILRACE WEIR; BOREL STATION

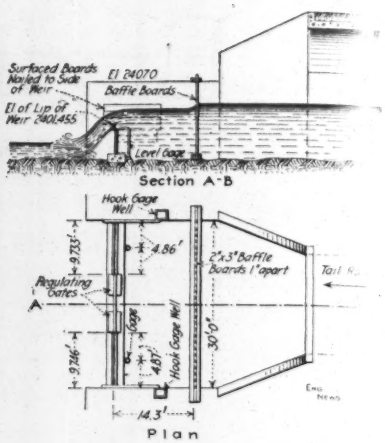


FIG. 4. DIAGRAMMATIC LAYOUT OF TAILRACE WEIR

outside packed, and of carefully plotted curvature to insure good efficiencies at fractional loads. A cast-steel gate ring, actuated by the governor, controls the synchronous movement of these wicket gates through suitable levers and links.

The turbine runner is of manganese bronze and great care was taken in the molding to insure smooth water surfaces, which were afterward hand-scraped and

FIG. 5. PRESSURE-GAGE CONNECTIONS

machined. The runner is hydraulically balanced by means of balance chambers on each side, but a double-disk thrust bearing, with automatic ring-oiling device, is also provided. The runner discharge occurs over a fixed conical thimble surrounding and protecting the shaft and extending into the draft elbow. The reaction from the runner is thus taken up by this stationary discharge thimble, which reduces the end thrust on the bearing.

The draft tube extends from the flange outlet of the draft elbow a distance of 27 ft. below the shaft center line, flaring suitably to reduce the discharge velocity to a minimum. The casting covers are made parting to facilitate access. The shaft where it extends through the packing glands is protected from wear by a suitable parting bronze wearing shield, which can be readily replaced. The water passage between the wicket gates and runner is protected by bronze liner plates readily replaceable in the event of wear. Aside from the adjustment provided for the wicket gates, the connecting rods between the gate ring and governor rocker-shaft are adjustable.

In most installations a synchronously operated relief valve is direct-connected to this rocker-shaft to prevent water ram in the pipe line on governor action at load changes. In this particular plant, however, the governor works directly on the wicket gates, but is set to make the stroke slow enough to prevent a material pressure rise in the short pipe line.

The first unit was completed and installed during March, 1911, and on Apr. 21 and 22 an elaborate test was made by James H. Wise, representing J. G. White & Co., acting hydraulic engineers for the purchaser. The efficiency was found to exceed the guarantees (the maximum efficiency being 85.5%) and the construction of the other three units was started at once.

TESTS OF FRANCIS TURBINE—The efficiency test was interesting, as it was made with every possible refinement, electrical as well as hydraulic.

For measuring the water a permanent weir was built in the tailrace. It consisted of two weirs, each 9.75 ft. wide and about 10 ft. apart. Two hook gages were used and an average of six readings of each gage was taken for determining the flow of water over the weir. The Francis formula, allowing for end contraction and velocity of approach, was used in computing quantity. Baffle boards, evenly spaced, were set 15 ft. back of the weir crest in order to get a perfectly even flow of water over the weir. The velocity of approach did not exceed 1 ft. per sec. at any test.

For measuring pressure head at the turbine, a Bourdon gage was connected to a piezometer ring on the inlet pipe

FIG. 6. MERCURY VACUUM GAGE ON DRAFT TUBE

(Fig. 5) and the average of the pressure at quarter points of the pipe was obtained. The gage was checked in place before and after the test with a dead-weight gage tester.

Vacuum was measured by means of mercury U-tubes at quarter points on the draft tube. The actual distance from center line of shaft to tailrace level was

also measured for establishing the draft head, which varied from 24 to 22.66 ft.

For calculating the input to the turbine, the total effective head was taken as pressure head in the supply pipe at the turbine plus velocity head of the water at this point, plus draft head, all corrected to center line of shaft.

Electrical-output and generator-loss measurements were made with indicating and integrating wattmeters. At first the generator of the unit under test was paralleled with the transmission line and partly loaded, but it was found that its potential could not be raised above 2000 volts with unity power factor on the generator. As it was desirable to run the test with as near the normal terminal voltage of 2200 as possible, another unit was started up and its generator paralleled with the line. Then the water of this unit was shut off, allowing it to float on the line; by over-exciting its field, the transmission voltage was raised, so that the generator under test could be run at practically nominal terminal voltage and unity power factor. All the other generators were shut down during the entire test.

As all the generators of this power station operate with the neutral point of the armature winding grounded, this ground connection was cut off during the test in order to prevent the possibility of any power being exchanged through this

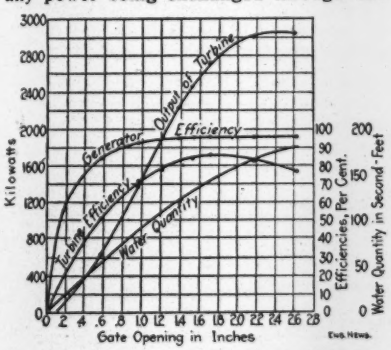


FIG. 7. DIAGRAM OF RESULTS OF TESTS ON A FRANCIS TURBINE AT THE BOREL STATION

neutral and the third leg, which did not pass through the wattmeters.

Immediately after the full-load trials, the generator was shut down and the hot armature resistance taken by the drop-of-potential method. In determining iron, friction, and windage losses, the generator under test and one other were put onto the transmission line; then water was shut off the unit under test and both generators were cut off from the line. Under these conditions, the second unit drove the one under test, the energy supplied being that required for iron, friction and windage losses plus a small heat loss from the light currents in the armature which could be corrected for. The generator under test was given proper increased field excitation for each point of the full-load tests. The voltage of the driving generator was varied so as to give unity power factor of input to the other. The driving generator was held at 50 cycles by the man operating the turbine gates, who had a frequency meter at his post.

From Fig. 7 it will be seen that the maximum efficiency of the generators ran as high as 95.7% for full overload and 92% at half load.

J. H. Wise, who was in charge of the hydraulic tests, is now assistant general manager of the Pacific Gas & Electric Co. Jos. Mini, Jr., was in charge of electrical tests; Edward Woodbury and Emil Newman represented the purchaser during the trials.

## The Slipperiness of Tarred Roads*

It has been suggested by the Roads Improvement Association that the slipperiness of tarred roads may be due to either of two causes, the use of calks on horseshoes, or a method of "topping"—precisely what method is referred to we do not understand. While to one or to both of these conditions there may be due—though we do not know that there is—the very bad state of some roads, it is certainly a fact that to neither of these should we look for the causes of the slipperiness of the very large mileage of roads which have either been slippery in frosty weather or slippery in muddy weather since the break-up of the summer.

Probably the bad state of these roads this winter—and they seem to be much worse than last winter—is largely due to the fact that the long spell of dry weather prevented partial anticipations of the present and recent muddiness, and the partial removal of the slimy materials by heavy rains in summer and autumn. Added to this, we have the fact that the large amount of tarring done, without a proportionate increase in staff and machinery, led to a considerable mileage of the roads being tarred very late, and much after what is usually regarded as the proper time. So, altogether, the tarry matter had not worn off as much as usual. This led to the roads on which the film was well preserved, or those in which there was an unusually large amount of tarry binder near the surface, being more than usually slippery when the weather was frosty—this more especially on exposed roads. On the other hand it led, during spells of drizzling or gentle rain, to the formation of greasy mud—this more especially on roads in cuttings or in narrow streets.

There are three more contributing causes in the case of such roads. In narrow streets the lack of circulation of air and the concentration of traffic made matters worse, while a great many roads in cuttings and on hillsides were subjected to the action of seepage water, sometimes oozing onto the surface, sometimes entering the crust from below, and in other less severe cases making the subsoil so wet that there was no draining away of the water, which began to penetrate the crust where it was broken, or from puddles. You cannot make a silk purse out of a sow's lug, and you cannot make a good road crust on a badly engineered road.

It may also be noted that on account of the cost of making wide cuttings the road is often narrowed where it is in cutting, so that we have concentration of traffic in these places. The slipperiness due to greasiness has been worst, other things being equal, where the traffic has been heaviest; and on days when it was hardly safe to ride a bicycle on the urban roads, or on parts of main roads, where traffic is increased by large local contributions, the secondary roads have been in a much better state, and the tarred roads with light traffic better still.

Another cause of the greasiness has to be taken into account—namely, late retarring, either complete or in patches. The tar which had been only a short time on the road worked up into an emulsion under concentrated traffic more readily than did the tar which had been left long enough to set, and the greasiness was worse, because a smaller amount of gritty stuff had been worked into the tar.

We do not think that it has been usual to sharpen horseshoes or to put in studs in wet weather, and if the tarring of roads is leading to this being done, that it is a matter which demands serious consideration. Horseshoes are sharpened, not in black frosts, as a rule, we believe, but when long, rimy frosts make hard roads become slippery under the action of traffic, and more especially when partly melted snow is being beaten into an ice sheet by the traffic, or soft snow has fallen to some depth; and, of course, when a hard frost begins at a time when the roads are very wet and slushy.

Without giving up the idea of forming a carpet layer by successive coatings, at any rate in flat country, the more immediately useful principle seems to be that of tarring early and lightly, with a view to the tarry matter being worn in and worn off by the winter sufficiently to prevent the roads being considerably more slippery than are water-bound roads, either in frosty weather or in drizzling, rainy weather. The absence of heavy showers of rain at intervals during drizzling weather has been an unfavorable feature of the late autumn and early winter, and this may be counted as a contributory cause of the unusual greasiness of the roads. We have not exhausted the subject, but, if we have not let in a flood of light upon it, at least we believe the rushlight that we hold burns steadily.

*Editorial discussion in The Surveyor (London, Dec. 29, 1911).

# Raising the Dry-Dock "Dewey"

By L. S. Adams †

**The floating dry-dock "Dewey," made famous by the long voyage it made under tow from Baltimore, Md., to the Philippines, sank at its moorings at Olongapo some 18 months ago. Naval constructor Adams describes below the arduous work connected with its raising.**

The raising of the dry-dock "Dewey," which sank at Olongapo, Subic Bay, Philippine Islands, in May, 1910, was a wrecking operation somewhat out of the ordinary, and it is believed that a description of the methods employed and the difficulties and problems encountered in the work of raising will be of general interest.

*Paper read before the eighteenth general meeting of the Society of Naval Architects and Marine Engineers, New York, Nov. 16-17, 1911.

†Naval constructor, U. S. N.

## Sinking of Dry-dock

The "Dewey" is a steel, floating, self-docking dry-dock, with a lifting capacity of about 20,000 tons, a length over all of 501 ft., a clear width inside of the side walls of 100 ft.; and it can be sunk so as to have 37 ft. of water over 4-ft. blocks and still have 4 ft. of freeboard. The self-docking feature was secured by building it in three sections, securely bolted together to form one structure when used as a dock, but entirely separate when self-docking. The main or middle sections contain all of the boilers and main steam pumps, and other machinery. The machinery is all located on the port side, which is the side that sank, except one auxiliary boiler, some machine tools, etc., which are on the starboard side. The machinery is all located on what is called the machinery deck, which is 16 ft. 6 in. below the top deck of the side wall. The total displacement of the dock in the light condition without a vessel in it, is about 11,000 tons. The central pontoon is divided into 14, and each end pontoon is divided into five main water-tight compartments. These main compartments are still further subdivided by water-tight bulkheads, so that there are 32 water-tight compartments in the main pontoon and 18 in each end pontoon, making 68 in all. The general arrangement of these bulkheads in the forward half of the dock is shown on Fig. 2. These compartments have a depth of 18 ft. 6 in. below the floor of the dock.

Combined flooding and draining pipes with quick-acting gate valves lead from each of these 68 compartments to a main drain and flooding pipe running along in the bottom of the port side of the dock. The valves in each main compartment are all operated by one lever in the valve house, which is located on the upper deck of the port-side wall amidship. The pumping machinery consists of three 24-in. horizontal centrifugal pumps and three Babcock & Wilcox boilers. The pump engines are on the machinery deck, the pumps themselves being in the bottom of the dock. Each of these pumps has a capacity of discharge of about 35 tons of water per min. The flooding of the ballast compartment is accomplished from sea valves into the one system of piping which is used for both pumping and flooding. The main line of piping is fitted with a flexible connection where it passes from the main or central pontoon to each end pontoon. There are stop valves on either side of these connections and also other stop valves located in appropriate places in the main line of piping. All sea and stop valves are operated by means of handwheels on the top of the side wall. Each ballast compartment is fitted with a vent pipe leading up to the top of the side wall. These vent pipes in some cases necessarily pass through several other compartments before reaching the top of the side wall and the atmosphere. All the ballast compartments are in the bottom part of the dock below the dock floor with the exception of compartments Nos. 1 and 7, which extend up into the side walls, their tops being formed by the machinery decks on each side. These compartments Nos. 1 and 7 are by far the largest of all the ballast compartments.

In May, 1910, the blocks of the dock had been prepared for two torpedo-boat destroyers, which it was intended to dock early in the morning of May 24. On the afternoon of May 23, the dock was lowered to a depth of 26 ft. over the keel blocks, which left a freeboard of 15 ft. on the side walls. This lowering of the dock a night in advance was in accordance with the usual custom so as to have the dock in readiness and avoid delay. About 1 a.m., on May 24, 1910, the valve man on watch noticed that the dock had taken a slight list to port. He accordingly corrected this list by admitting water which lowered the dock to a depth of 27 ft. over the keel blocks. Shortly before 4 a.m., he noticed that the dock had again listed to port, and that the port side seemed to be rapidly going down. He called the dock-master, but before anything could be done, the port side was completely under. This was about 4.30 a.m. The starboard side also sank somewhat and was slowly filling with water. No cause was known then for the sinking of the dock; in fact, the cause was not definitely ascertained until the dock had been completely raised. It was known that much of the drainage piping had many small holes in it. Repairs had been made from time to time, but no complete overhauling had been made, it being the intention to give the dock and all its piping a complete overhauling at its next self-docking, which was scheduled to take place in about seven months. It was not believed that any small holes that there might be in the drainage piping could possibly be sufficient to cause the sinking of the dock or to even appreciably interfere with its operation. It was thought possible that one of the main ascertained that neither of these things had happened, and that there was no material damage to the dock structure. This was demonstrated to be the fact by opening the various compartments on the sunken side to communication with compartments on the starboard side where the action of the water in the starboard compartments could be observed. This will be described a little more fully later on in this paper. The work of raising the dock was, therefore, considerably complicated by the fact that the cause of its sinking was not known, and a great deal of investigation work was necessary in order to eliminate certain possible causes and to determine as far as possible the general condition of the structure, piping, etc. It may be well to state, in view of

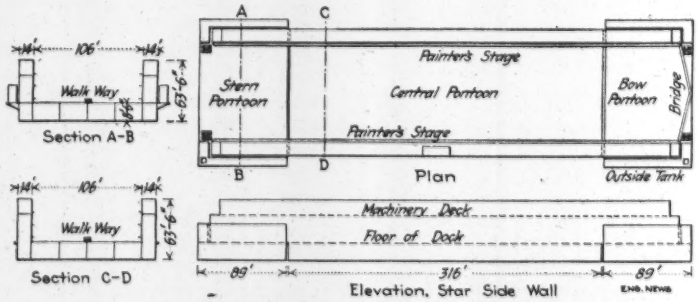


FIG. 1. OUTLINE PLAN AND ELEVATION OF DRY-DOCK "DEWEY"

many misleading reports published at the time the dock sank, that there were no open valves, and no open manholes, that were the cause of the sinking of the dock.

### Raising Dry-dock

Where the dock lay the depth of water over the bottom was about 65 ft. at the inshore or forward end of the dock, and about 70 ft. at the after end. The character of the bottom was soft mud to a depth of about 3 ft., and under that comparatively hard sand. The top deck of the side walls on the port side was about 6 ft. under water at the forward end, and about 16 ft. under water at the after end. These figures should be increased about 2 ft. for high tide and decreased 2 ft. for low tide. The outer edge of the bottom of the port side had sunk into the mud to a depth of about 10 ft. at the outer end, and kept sinking further into the mud until it was eventually about 18 ft. in the mud, before the dock was raised. On first sinking the starboard side remained afloat, but it was gradually filling with water. Work was immediately begun to save the starboard side. All openings in the top deck were closed water-tight, and five pumps were mounted below in the machinery spaces to pump water from No. 1 tanks up through the manholes. These pumps were all small plunger pumps, being in size 3 in. to 6 in. suction. Steam for these pumps was furnished from the dock's auxiliary boiler located in the starboard machinery space and also from a small tug.

Two days after sinking, the starboard side had gone down so that its outer end was about 3 ft. under water. By this time, however, the pumps had been mounted and were in operation and the starboard side was saved from further sinking and was raised until it was about 2 ft. out of the water at the outer end, and 12 ft. out at the inner end. These pumps had to be kept going day and night during the entire time until the dock was finally raised. There was always slow leakage to take care of.

Methods Proposed—The alternative plans determined upon for attempting to raise the dock were as follows:

1. By introducing compressed air into the port side of bottom tanks Nos. 4, 6, 9, 10, 11 and 12. This seemed at first sight the simplest and quickest method of raising the dock. Tank No. 7 was not to be utilized for the reason that the top of this tank was formed by the machinery dock which had many small openings in it, such as deck drains, steam drains, etc., which would have made the retention of air very difficult, and the other tanks had more than enough buoyancy to lift the sunken side.

2. By making water-tight the compartment in which the forward centrifugal pump for operating the dock was located; then clearing this compartment of water and operating the dock's own pump by steam furnished from the tug "Wompatuck." Before doing this, however, it was decided to attempt to hun this pump under water by means of compressed air. For clearing this compartment of water, a steel coffer-dam was built and fitted over the skylight coaming and a 10-in. centrifugal pump was mounted on a platform on the outside of the coffer-dam and its suction taken down into the compartment below through a small hatch. This pump had a lift of about 30 ft. to entirely clear the compartment of water. In addition to this, a duplex pump with 6 in. suction was mounted on the outside of the coffer-dam with its suction running down inside. This was in order to keep the water down in the compartment after it had been taken out by the centrifugal pump. The end bulkheads in this compartment were non water-tight and were very inadequately stiffened. Extensive shoring was necessary to provide against their collapse and considerable work was involved in making them water-tight.

3. By making the whole top and bottom decks and the side walls of the machinery space on the sunken side water-tight; then clearing this whole space of water, which would provide nearly 3000 tons buoyancy (about 5500 being necessary to lift the sunken side); and then by utilizing the dock's own pump to raise her or, in case of the failure of this, by mounting pumps below and pumping water out of the No. 7 compartments. This was the surest method, but also the longest and the most costly.

The second and third of these methods were based on there being no serious damage to the dock's structure and no large opening to the sea. This was conclusively demonstrated to be the fact by opening various other compartments into the No. 1 compartments on the starboard side, and then observing the action of the water in the No. 1 tanks. The opening of the other compartments into the No. 1 compartments was accomplished through the dock's pumping and drainage system, the valves in the valve house being operated by divers. This showed general leakage, but not enough for any large opening to the sea. Furthermore, such examination as could be made of the dock by divers did not disclose any open manhole nor damage to the dock's structure. The sea valves and the connections of the drainage pipes between the middle and end pontoons were, however, inaccessible by divers and could not be examined.

First Attempt—It was necessary that the raising of the dock be accomplished as soon as possible owing to the approaching typhoon season which was due in about one month. Therefore preparations for the three methods of raising the dock were begun at once and at the same time. For the first method, power floats containing air compressors and boilers were fitted up at Cavite and sent to Olongapo. There were two floats containing each a compressor of from 400 to 500 cu.ft. of free air per minute capacity compressed to 100 lb., and one other float containing five small torpedo air-compressors obtained from the torpedo testing room. Twenty manhole covers were manufactured, each containing a 1½-in. air connection with cut-off valve for introducing compressed air, and a 3-in. pipe running through the manhole and extending down to a depth sufficient to reach within 1 ft. of the bottom of the tanks. The latter pipes were for the ejection of the water and were also fitted with cut-out valves at the tops. These manhole covers were placed in position by divers. It was considered hopeless to attempt to introduce compressed air through the vent pipes, particularly in the end pontoons, as they were badly corroded and leaky, and furthermore this method was considered somewhat hazardous due to the fact that the flow of water from the tanks could not have been ac-

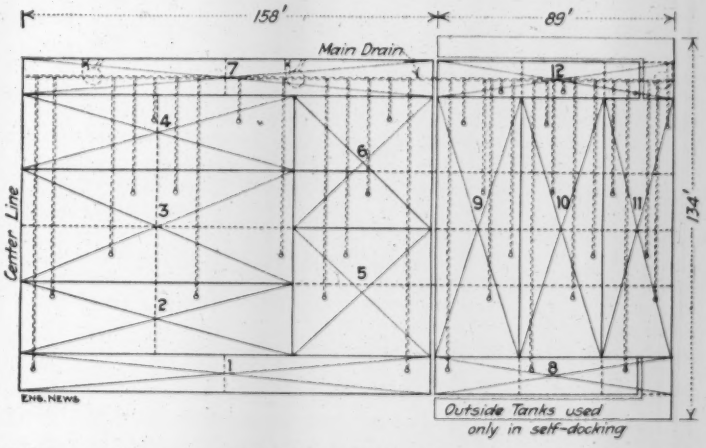


Fig. 2. Plan of Forward Half of Dry-Dock "Dewey" Showing Location of Water Tanks and Flooding Piping

curately determined as it would have been through the drainage system, and there would have been danger of damaging the tanks and bulkheads from excessive pressure. The method of introducing compressed air through manhole covers enabled the divers at all times to determine with absolute accuracy the action of the air and water, as the water could be plainly felt coming out the ejection pipes.

For the first plan of raising the dock, the 20 manhole covers were installed and all vent pipes plugged tight as far as possible. A large amount of work was involved in doing this, as in some cases whole sections of corroded pipe had to be removed or renewed by divers. In all, about 1100 ft. of piping were renewed. These pipes could not be made completely tight owing to the fact that some were leaky where they passed through tanks Nos. 8, 12, and the self-docking tanks, which places were inaccessible to the divers. However, they were made sufficiently tight to retain compressed air without excessive leakage.

Before introducing compressed air a hose from the accumulator was led to the floor of the dock. The pressure in this hose was increased until the air just came out at the end and such pressure was noted. A number of hose connections were then made to the various manhole covers and air was introduced at a pressure of 2 lb. in excess of the pressure already determined of the head of water outside. These connections were all to tanks on the low side, but it was found that the air went at once to the tanks on the high side. This was probably due in part to leakage through the vent pipes in the tops of the tanks, but it was mainly due to the fact that the tank bulkheads proved to be non water-tight at the tops, allowing air to pass freely from one tank to another. In one case the air went through five bulkheads, one of them being the center-line bulkhead which had no pipes whatever running through it. In all cases the air forced the water out of the tanks on the high side first, through the drain piping and closed valves, lifting the high side only. This non water-tightness of bulkheads at the tops was not known before attempting to introduce the compressed air, there being nothing in the plans and specifications to show it. This method of lifting the dock was, therefore, proved to be impracticable and even dangerous from the excessive pressure that would have been produced in the tanks on the sigh side when that side had been raised out of the water, and the outside head lessened. Consequently it was abandoned.

SECOND ATTEMPT—It was then attempted to operate the dock's forward centrifugal pump under water by means of compressed air, the exhaust pipe having been run above the water-line from the outboard connection through the side wall. The pump was started by this means, but only 30 lb. pressure could be obtained with the air plant available, and this was not sufficient to eject any water against the outside head. In fact, a minimum of 80 lb. pressure is required under normal conditions to operate this pump. This method was also abandoned. Subsequent events showed that it would have been impracticable even had sufficient air capacity been available.

The second method of attempting to raise the dock by steam on its own pump was then taken up. After many annoying difficulties, the pump compartment bulkheads were finally made water-tight, the bulkheads sufficiently strengthened and the compartment cleared of all but about 2 ft. of water. About 3 p.m., on June 14, 1910, the dock's own pump was gotten in operation by steam from the "Wompatuck." The discharge had already been cleared by divers digging away the 14 ft. of mud and hard sand in which it had sunk.

The starboard side came up first, the pump taking water from the tanks in that side before it would take any water whatever from the tanks in the low side. The vent pipes from the tanks in the low side had been fitted with hose connections to the atmosphere and there was no indication of any air going into them, which would have been the case had the pump been taking water from them. This was due chiefly to the fact that all compartment valves are of the quick-opening type, many being operated by one lever, which prevents them from being anything but approximately tight. The leakage was, however, far greater than had been anticipated. Furthermore, these valves occasionally break in use and no doubt some were broken. Also some of the drainage piping was leaky through small holes in it and this also allowed water to pass from some of the compartments to others. No matter which valves were open or closed, the pump took water from the high tanks before removing any from the low tanks. This action was wholly unlooked for. This operation was then stopped temporarily. The No. 1 tanks on the high side were then completely filled with water and the vents plugged. At about 9.30 p.m. the dock's pump was again started with the same result as before. The starboard side came up first, and at about 5 p.m. the next morning it had been raised to about 14 ft. on the draft board at the forward end. (These drafts are over the keel blocks.) It was then noticed that the forward end of the sunken side was beginning to come up very slowly, and the operation was continued until the whole forward end began to come up rapidly. The starboard after corner was going down, and the port after corner was coming up very slowly. At this time the pump was drawing water from tanks Nos. 4, 6 and 7 forward, but practically none from Nos. 4, 6 and 7 aft. Both end pontoons were completely shut off by the stop valves. Both No. 1 tanks on the high side were practically empty of water. The whole forward end pontoon was completely full of water. The water in the forward end pontoon was beginning to be lifted above the surface. The weight of the end pontoon together with the water in it was in the neighborhood of 7000 tons, and it was considered dangerous to continue this operation further. To have done so would surely have resulted in straining the dock and probably in tearing off the end pontoon. At the time the operation was stopped, no deflection of the dock structure could be noticed and there was no sign of giving way of the bolts securing the end pontoon to the side walls of the center pontoon. Furthermore, this operation alone would not have raised the dock, for the reason that as soon as the forward compartments were emptied, the pump suction would have drawn air, after which the suction to the after tanks would have been lost and the after end could not have been lifted by that means.

It was then planned to introduce compressed air in the after pontoon, in order to lift the after end of the dock. It was, however, doubtful whether the dock could be satisfactorily raised in this manner, as this also would have lifted the high side first, and it was feared that severe strains might have been put on the dock due to the fact that the port after corner would have served as a pivot while the rest of the dock was rising first. However, it was decided to attempt this with the idea of discontinuing it if the action of the dock was not satisfactory. For this purpose the dock's pump had to be kept going from time to time, in order to keep the low side from sinking through leakage. About 4:30 p.m. it was found that the dock's own pump was in such bad condition due to having been working in mud and salt water and at an excessive inclination and also due to the breaking of the oiling gear, that it needed overhauling. It was accordingly stopped for repairs which were not completed until about midnight, at which time the port side was just sinking below the surface. This method of lifting the dock was then abandoned, it being considered a dangerous one even with the assistance of compressed air and the action of the compressed air being very uncertain.

SUCCESSFUL METHOD—The third method of raising the dock, outlined above, and for which preparations had been in progress, was then begun. The whole sunken side was made water-tight, the bulk of the work being on the top deck of the side walls, which had a great many non water-tight openings in it. Five coffer-dams were used as follows:

The first coffer-dam from forward was the one previously fitted for obtaining access to the dock's own forward pump.

The 10-in. centrifugal pump and the 6-in. pump were retained on this coffer-dam for use in pumping out the whole machinery space after opening up the end bulkheads of the pump compartment that had previously been made water-tight.

The second was a large one about 5 ft. 6 in. x 7 ft. 6 in. and was mounted on the dynamo-room skylight coaming. This coffer-dam was for the purpose of lowering pumps through it, to be mounted on the deck of the machinery space below in order to keep the water down after it had been removed and the upper pumps having lost suction, and also in order to install pumps (if found necessary) for removing the water from the No. 7 compartments. No pumps were mounted on this coffer-dam.

The third coffer-dam was mounted on the skylight coaming over the dock's middle centrifugal pump. There was mounted on the outside a plunger pump with a 6-in. suction, taken from the "Piscataqua."

The fourth coffer-dam was built over the door to the valve house and was for providing access to the interior of this house for the operation of the valves. All windows and ventilators in this house had to be made tight and the house had to be very heavily shored inside. It was built of thin plating, non water-tight, and it was necessary to make it water-tight for the reason that the deck inside of it could not be made so where the valve operating gears passed through it.

The fifth coffer-dam was mounted on the skylight coaming over the after dock pump and a 12-in. plunger bucket pump was mounted on the outside, the suction pipe going down inside the coffer-dam. All these coffer-dams were of steel and were shored from the deck of the dock, with the exception of the coffer-dam over the valve-house door, which was of wood.

A great deal of diver's work was involved in closing all openings in the top of the sunken side. These were made water-tight as far as practicable and the pumps mounted on the coffer-dams were then started. They took the water down about 4 ft. below the deck in the forward coffer-dam, after which the head of water outside was sufficient to make the leakage too great to be taken care of by the pumps. The divers were then sent down to make a complete examination of the deck and side walls. The leaks could then be easily found, due to the fact that water was running in then and could be plainly felt by the divers. All such leaks were accordingly made water-tight, after which the pumps had no difficulty in removing the water. The 10-in. centrifugal pump mounted on the first coffer-dam could alone remove the water. The pump on the after coffer-dam did not operate satisfactorily when it had to lift water a greater height than about 16 ft. About 2000 tons of water were removed from the machinery spaces, the machinery deck being bare of water at the high end and containing about 10 ft. of water on it at the low end. After this, the centrifugal pump lost its suction, but the 6-in. duplex pump on the forward coffer-dam and the pump from the "Piscataqua" on the third coffer-dam were sufficient to keep the water down, but could not remove all of it. A duplex pump with a 6-in. suction and a powerful horizontal pump with an 8-in. suction were then placed below through the second coffer-dam and mounted on the side wall stiffeners and on the deck respectively in the dynamo room. These two pumps removed sufficient of the remaining water to clear the dock's own central centrifugal pump for operation. At this time there were only about 600 tons of water remaining in the machinery spaces, the deck being bare to almost the middle of the dock. Steam was then connected to the dock's forward pump and the dock's middle pump through flexible piping from the "Wompatuck" into the main steam line of the dock which was blanked off just abaft the central pump. It was considered desirable and a safeguard to have two of the dock's own pumps ready for operation, so that the work would not have to be stopped in case one pump should break down. The exhaust piping from the central pump was led up through the coffer-dam above it to the atmosphere.

In the meantime, while this work was in progress, compressed air was being pumped into the after end pontoon through five manholes on the low side. The pumping of the air was continued for 36 hours, at the expiration of which time the starboard after end had lifted about 3 ft. and the port after end about 4 in. The pumping of the compressed air was then stopped. This was 38 hours before the dock's pump was started for finally lifting the dock. During these 38 hours some of the air escaped through leaky vent pipes, but the amount was small compared to the total quantity introduced. The after end of the dock was, therefore, almost afloat at the time the dock's own pump was started for raising. By this time the port side of the dock had sunk about 4 ft. farther into the mud than it was at the time the dock sank. The floating or lifting of the starboard side always forced the port side farther into the mud so that wood extensions had to be built on two of the coffer-dams first installed. The dock's central centrifugal pump was started about 2:30 a.m., on June 29, 1910. That night there was a strong wind and a heavy rain. The valves of tanks Nos. 6 and 7 aft were the only ones open at first. All forward tanks were shut off and the stop-valve in the main line was closed just abaft the dock's forward centrifugal pump. This stop-valve shut off half of compartments 1 and 7 forward and also some smaller intermediate compartments in the central pontoon, as well as the whole forward-end pontoon. After a very few minutes from the time the dock's own pump was started it was noticed that the after end, which was already nearly afloat, was beginning to come up. After about fifteen minutes' pumping the whole after end was seen to be coming up rapidly and the forward end of the sunken side was coming up slowly. The starboard forward corner was being forced down. This condition continued until the after end of the sunken side had been raised about 4 ft. higher than the forward end of the sunken side. At this time the deck of the after sunken end was just coming out of the water. The forward compartments on the sunken side were then opened to the centrifugal pump, after which the sunken side came up uniformly and there was no further difficulty in having absolute control over the dock. The additional 2400 tons of buoyancy obtained by clearing the machinery spaces, together with the compressed air in the after pontoon, gave sufficient buoyancy to the sunken side and low end so that it came up before there was any appreciable lifting of the high side, such as had been the case when it was attempted to raise the dock by one of her pumps alone. The dock came up perfectly from the start. It was desired to begin lifting the low end slightly ahead of the high end so as to provide a fairly equal height of water in all the tanks and thus obtain better control over the action of the dock. Furthermore, it was feared that if the dock were to be lifted on an even keel in the fore and aft direction, the sunken side might come up with a jump on breaking away from the mud. This might have been accompanied by disastrous results, such as carrying away the big flexible steam hose or striking some of the power floats or the "Wompatuck." By daylight, at about 4:45 a.m., the sunken side was well out of the water and the machinery spaces were opened up for access. Three-quarters of an hour after this, steam was up on the dock's own forward boiler in the sunken side and the "Wompatuck" was later disconnected and the final completion of the raising was done by steam from the dock's boiler. By 7 a.m. the floor of the dock was completely clear of water, but the pumping was continued to bring the dock to the light condition which was accomplished about 10:45 a.m.

In clearing the machinery spaces of water on the sunken side, the side and end walls had to stand a pressure due to a head of water of about 26 ft. It was known that this would give an extensive pressure. Accordingly, as the water was pumped down, the walls were carefully observed, as far as practicable, ot determine the deflection. The after end wall and the outer side wall aft on the sunken side buckled in slightly and have

a permanent buckle of about 4 in. This, however, is immaterial and does not affect the efficiency of the dock. It is hardly noticeable except on sighting along the surface. Also, in spite of the shoring, the valve house was badly buckled out of shape, due to the water pressure, and had to be rebuilt.

### Cause of Sinking

As soon as the dock was raised a careful and complete examination was made of the entire structure and all of its piping and fittings. A number of small new holes were found in the drainage and flooding piping. These could not admit water from the sea except in case one or more of the main sea valves should be open or leaky, so that these holes most likely had no appreciable effect on the sinking of the dock, except to make the listing more rapid. In fact they were hardly sufficient to even materially interfere with its operation and handling. The main sea valves were slightly leaky, but this leakage also was insufficient to cause or even to contribute to the sinking of the dock. The vent pipes from the tanks were, however, found to be badly corroded, in many cases being reduced to a mere shell which had given way, thereby leaving large areas open to the sea. When the dock is up these vent pipes are always above the surface of the water, but when the dock had been lowered to take in the torpedo-boat destroyers, these vent pipes were mostly under water, and water entered them and gradually filled the ballast compartments of the dock, which caused its sinking. The reason for its going down so rapidly is believed to be that when it once began to take a list to port the water from the starboard side flowed to the port side through the quick-acting gate valves in the drainage system, which are only approximately watertight, and also through the small holes in the drain piping. This, of course, increased the list of the port side, even though not admitting any additional water from the sea.

### Divers' Work

I think that this article is not complete without making mention of the excellent and efficient work done by the divers. There were at work on the dock about a dozen Filipino divers and six divers who were petty offcers on the torpedo-boat fleet. These latter were under the charge of Gunner G. D. Samonski, U. S. Navy, himself an experienced and efficient diver. His and their work was, in my opinion, of an unusually efficient character. These men were at work almost day and night for five weeks. The heavy work of fitting the manhole covers, with its long piping, had to be done in a depth of water of about 70 ft., and some of this work was in very cramped and almost inaccessible places. They had to go below on the machinery deck to find and close numerous small openings where they had to pick their way among all sorts of machinery, stanchions, pipes and other obstructions where the work was of a dangerous nature. They renewed or removed about 1100 ft. of 3- and 4-in. vent piping under water. They had to dig out about 14 ft. of mud and hard sand to clear the sea valves at a depth of 85 ft. below the surface. In no case did any of them wear a diver's suit. The helmet alone was used. This seems to be somewhat unusual, in this part of the world at least, where the water is usually too cold and makes the entire suit necessary. But without the suit the diver has more freedom of action and can do better work; only he must always keep his head upright. In this work on the "Dewey" there would probably have been loss of life had divers' suits been worn in some instances. Occasionally when introducing compressed air a pipe would give way and, in several instances, divers were working on pipes that gave way under the compressed air. This released a large volume of air, upset the diver, and almost upset the boat containing the diver's tenders and apparatus, thereby shutting off the supply of air. With the helmet alone, the diver could easily get out of it and come to the surface. The work of these men fully deserves special commendation and thanks.

## The Adulteration of Portland Cement*

By R. C. Carpenter†

Because of the low price of portland cement prevailing at the present time, it is one of the materials in which adulterations would seem improbable, and so far as the manufacturers in this country are concerned, I believe this assumption is not only reasonable but it is also true.

It has been claimed that by the use of certain adulterants in portland cement that the quality could be improved rather than otherwise, and so far as investigations have been made in the past, there is a good deal to support such a statement. It is very important from the manufacturers' standpoint to ascertain just what effect the mixing or grinding of certain inert substances has on the cement. This information is also important for the engineer who is to use the cement. In general, the grinding in of inert substances will lessen the cost of manufacture very nearly in proportion to the use of the inert substance. The result, therefore, would be to give the manufacturer making or selling the adulterated cement a large advantage over his competitors and correspondingly to handicap the man who was manufacturing pure cement which was sold in competition with adulterated cement.

In this article it is intended to give a brief résumé which the use of various adulterating materials have been proved to have upon the quality of the cement.

It may be well to call attention to the character of the manufacturing process for portland cement. Briefly stated, this consists in grinding together definite quantities of lime and clay which are later burned at an extremely high temperature and finally ground to a fine powder. Some gypsum, usually about 2%, is ordinarily ground with the cement in the final grinding to regulate its setting.

The simple statement of the process as above gives very little notion of the machinery required for power, quarrying, grinding and conveying the various materials. It must be sufficient at present to state in this connection that the cement industry is a very important branch of applied mechanical engineering and that the construction, design and operation of these plants call for a high-grade engineer.

In the manufacture of portland cement the product is affected by (1) the character of the raw materials; (2) the proportion of the various chemical ingredients; (3) the fineness of grinding both of the unburned and of the burned material; (4) the thoroughness of the burning operation. Unsound or weak cement will result from the failure to maintain any of the manufacturing operations up to its proper standard.

Portland cement is almost always used in connection with sand, water and broken stone, to form a mortar or concrete. It is the most extensively used today of any building material, and because of its stone-like properties and its wonderful endurance, its use is constantly increasing. The manufacture of cement is for this reason one of the large industries of the country and one which gives employment to a great number of mechanical engineers.

Adulterations in portland cement have generally been looked upon as detrimental to its quality and the specifications adopted for its use have been of a character to exclude it. If, however, it should turn out that certain inert quantities used in quite large proportions resulted in improving the cement from every standpoint, as is claimed by certain investigators at the present time, it would seem proper to change the specifications so as to give the consumer the advantage of the better material and lower prices. The present specifications which have been adopted by the American Society of Civil Engineers define portland cement as "a finely pulverized product resulting from the calcination to an incipient fusion of an intimate mixture of properly proportioned argillaceous and calcareous material, and to which no addition greater than 3% has

*Reprint from "The Sibley Journal of Engineering," Dec., 1911.

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been made subsequent to calcination." The definition as given above would preclude the use of an adulterated material under the name of portland cement.

Respecting the adulteration of cement, the following inert materials have been ground with it previous to calcination at different times, and a considerable amount of building work has been executed with such adulterated cement.

a. Clay, either raw or burned.
b. Slaked lime.
c. Sand.
d. Ashes.
e. Natural cement.
f. Products of natural rock like ragstone or tufa.

Natural cement, which is made by burning natural deposits of magnesia and limestone rock, was at one time extensively manufactured in eastern New York and generally sold under the name of Rosendale. This material could be made very cheaply and it was generally put on the market rather coarsely ground. It has the property of setting very quickly, but at the end of a month would hardly attain the strength that portland attained in one week. This cement was used extensively and a long lapse of time has proved it to be sound and reliable. At the present time the amount of Rosendale made is very small and it is not available as an adulterant.

I have known personally of grinding into portland cement of amounts ranging from 100 to 150% of natural cement and I have made various investigations of the resulting product. I also have had occasion to examine recently some constructions built with such material about twelve years ago. My investigations indicated that portland cement could be ground with practically an equal amount of Rosendale cement with no loss in its sand-carrying quality or its strength. In some cases the effect of grinding the Rosendale into the portland was to improve the strength and hydraulic properties of the mixture.

Very fine sand ground into the cement has been used extensively as an adulterant. I know personally of the extensive use of material of this kind a number of years ago and from which no bad results have been experienced; on the contrary, the results apparently are equal to those obtained with the pure portlands. Some fifteen years ago Capt. W. M. McClay, formerly of the Dock Department, New York City, and later president of the Glens Falls Portland Cement Co., took out a patent for the grinding together of portland cement and sand, forming a siliceous mixture which was sold as "silica cement." The good results obtained with this material were thought by many engineers to come largely from the extra grinding which the portland cement received when the sand was added. The cementing properties of a portland cement are known to increase with the degree of fineness and this explanation seems to account at least in part for the results. This material was used in a good many structures, notably in a dam across the Mississippi River near St. Paul, built by United States engineers. The expense of it as compared with pure portland cement is responsible for its disappearance from the market. Some engineers have reported respecting "silica cement" that its strength fell off when mixed with large quantities of sand as compared with pure portland cement used under the same conditions; in other words, that while it might be better than pure cement when used neat, it was inferior when used with standard quantities of sand. It is quite evident that any inert material to be of value must not lessen the good qualities of the cement when used with normal amounts of sand.

The use of various percentages of clayey material for grinding into portland cement, after calcination, has perhaps not been extensive, but investigations tend to show that such material has no detrimental effect on the cement and can be added in quite large quantities without reducing the strength of mortars even when used with large quantities of sand.

I merely call attention here to one investigation made on a mixture of three of sand to one of cement, in which different quantities of clay were used, and which shows a large increase in strength as the per cent. of clay is increased to 15%, and which is retained throughout the period of testing.

TENSILE STRENGTH, LB. PER SQ. IN.

| Age | 1 month | 3 months | 1 year |
|---|---|---|---|
| No clay | 200 | 335 | 390 |
| 2% clay | 330 | 370 | 430 |
| 6% clay | 300 | 470 | 490 |
| 10% clay | 370 | 450 | 590 |
| 15% clay | 400 | 500 | 620 |

Quite recently it has been proposed, especially on the Pacific Coast, to grind a volcanic tufa having composition very much like clay, with cement. In the construction of the Los Angeles aqueduct the portland cement used in the later period was adulterated as much as 200%, by the grinding in of this material. I have myself taken part in investigations comparing the results from this adulterated material with the results obtained with pure cement. Up to the present time such investigations have not indicated that the practice of grinding in the tufa was dangerous or that the resulting structures were weak and would not be permanent. Sufficient time has not elapsed to make it safe to draw any conclusions other than those stated above from my investigations. When later investigations to which reference has been made are completed I believe our conclusions in this respect will be of value.

Slaked lime has been frequently ground into portland cement after calcination and I have also investigated that practice. This material has a decided effect in regulating the setting and also tends to make the cement waterproof. Added in quantities up to 50%, it does not reduce the strength for normal quantities of sand, and so far as my investigations show it does not lessen the value of the completed work. Slaked lime must be used with care since any particles which are not thoroughly hydrated will tend to make the cement unsound. It is rather expensive and is not likely to be extensively used because of that fact.

The action of these inert materials, in many cases, in improving the quality of portland cement rather than injuring it, is in harmony with the theory of Michaelis, which is now generally adopted by all scientific investigators. Michaelis' theory in brief attributes the setting of cements to the desiccation of the colloidal hydrated aluminum silicates, formed when the cement is mixed with water and the later hardening as due to the formation of colloidal calcium silicate and calcium hydroxide, the latter in the crystalline form. This theory is essentially different from the Le Chatlier theory previously held by scientific observers and which attributed the setting as principally due to the formation of various calcium silicates.

As the colloidal properties are greatly increased by fine grinding, it becomes evident at once that the value of a cement depends largely upon the fineness of its particles. Many of the inert materials mentioned, especially the clays, have distinctive colloidal properties, hence it is easy to see that the addition of material of such a character within certain limits might exert a beneficial rather than a detrimental effect.

The present investigations so far as completed would indicate that portland cement is not injured in its practical use by the grinding in of a number of cheap materials after calcination which are decidedly of the nature of adulterants. On the contrary, in many cases, investigations show a decided improvement in every desired quality. Provided the completed investigations show that the quality is improved by certain kinds of adulteration, the question will at once arise why should not the specifications for portland cement be changed so as to admit such a practice, thus materially reducing the cost. The principal reason for not admitting adulterations is the same one that holds respecting pure foods for the cases where the adulteration is harmless, and that is the difficulty of controlling the amount and character of the adulterant. It is almost impossible to obtain an adulterated material which is of uniform character and which is made as represented. Specifications permitting adulteration would be difficult to enforce and consequently the results obtained with adulterated material would be uncertain.

# Gas Combustion at Hot Surfaces

**Hot surfaces have an accelerating effect on the combination of mixed gases. If an explosive mixture of fuel gas and air is forced through an incandescent porous diaphragm an extremely rapid combustion takes place at the contact surfaces and the heat developed keeps the material glowing. This is a flameless combustion of gas.**

**By packing the tubes of a multitubular boiler with crushed firebrick and forcing the gas through as before, over 90% of the heat of combustion can be utilized in raising steam, if a feed-water heater is made a part of the boiler system. The capacity of such a boiler is about double that of the common type, as ordinarily run.**

At the last convention of the American Gas Institute, in October, 1911, and later in New York City, Prof. W. A. Bone, of Leeds University, Leeds, England, lectured on the effect of incandescent surfaces in accelerating combustion of a mixture of fuel gas and air, and on some commercial utilizations of the phenomenon which were being attempted. The following paragraphs are brief abstracts of parts of Prof. Bone's paper.

The fundamental fact is that all hot surfaces have an accelerating effect on the chemical combination of gaseous mixtures. For instance, if a mixture of hydrogen and oxygen in combining proportions be maintained within closed glass walls, at 450° C., there would be a slight tendency to form steam. If some porous material at the same temperature be introduced, so that a much larger surface is exposed to the gases, then the time-rate of change would rapidly increase in the layers of gas immediately in contact with the surface. The rate of combustion, although now quite measurable, would still be insufficient to cause self-heating; the temperature would remain at 450° C., which is below the ignition temperature of the mixture or the point at which incandescence begins.

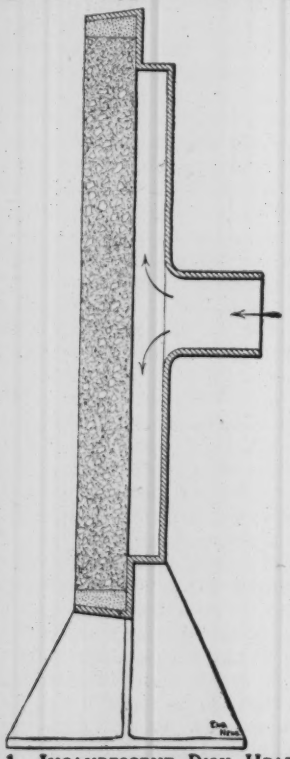

FIG. 1. INCANDESCENT DISK HEATER; FLAMELESS GAS COMBUSTION

Two conditions of gaseous combustion have to be noted: (1) Homogeneously or throughout the mixture as a whole; and (2) heterogeneously or in layers in contact with an incandescent surface. The first condition may involve slow combustion at low temperatures and without flame, or rapid combustion at temperatures above the ignition point and accompanied by flame. The second condition is that of the so called "surface combustion" which is claimed to be a faster process than homogeneous combustion.

If an explosive gaseous mixture is forced through a porous incandescent diaphragm, an extremely rapid combustion takes place within the pores of the solid, that is, at the boundary layers between the gaseous and solid matter. The heat released by this intensified combustion maintains the surface in a state of incandescence without flame.

This is the starting point in the design of radically new apparatus for industrial heating. With such appliances the efficiency of heating operations is greatly increased. When "porosity" is spoken of, molecular porosity is meant. A solid may appear dense and yet be highly porous to the molecules of a gas; it is only vitrified surfaces, such as glass, that are relatively non-porous, and even glass, when depolished, is sufficiently porous to induce slow surface combustion.

The incandescent solid plays a specific part in surface combustion, but the manner in which it acts is still a matter of conjecture. At a discussion of the British Association in 1910, Sir J. J. Thomson suggested that it was not improbable that the emission of charged particles was a factor of primary importance.

The advantages claimed for the new system are: (1) Great acceleration of combustion by the incandescent surfaces which may be located just where the heat is to be concentrated; (2) the combustion is perfect with a minimum excess of air; (3) very high temperatures may be secured without the aid of elaborate regenerative devices; (4) owing to the large amount of radiation from such an incandescent surface, the transmission of energy from the seat of combustion to the object to be heated is very rapid. These advantages may be so combined that the new system is not only very economical, compared with present methods, but is easy of control.

If a homogeneous mixture of gas and air, in proper proportions, is allowed to flow under slight pressure from a suitable feeding chamber, through a porous disk of refractory material, it may be caused to burn without flame at the surface of exit which is maintained incandescent. The proper gaseous mixture for a disk heater such as shown in Fig. 1 may be obtained in two ways: (1) By means of suitable connections through a Y-piece with separate supplies of low-pressure gas and air, and (2) by means of an injector so that a supply of gas at some 2 lb. per sq.in. draws air from the atmosphere. To start up such a disk heater, with a Y-tube, the gas is first turned on and ignited as it issues at the surface; the air is then gradually added until a fully aërated mixture is obtained. The flame soon becomes non-luminous and retreats to the surface of the diaphragm, which becomes red with a curious mottled effect. All signs of flame disappear and there remains a bright, glowing surface, the radiation from which can be steadily maintained.

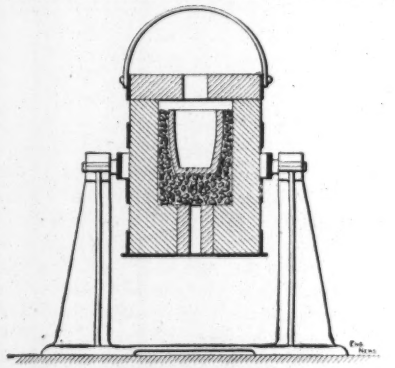

FIG. 2. A "SURFACE-COMBUSTION" MUFFLE FURNACE

Actual combustion is confined to a very thin layer, ⅛ to ¼ in. immediately be-

low the surface, and no heat is developed in any other part of the apparatus. While the front of the disk is intensely hot, the current of gas counteracts backward conduction of heat, and the back may be so cold that the hand can be held on it. The combustion of the gas is perfect, once the relative proportion of gas and air has been properly adjusted, and no unburned gas escapes from the surface. The temperature of the surface can be instantly varied by altering the rate of feeding of the gaseous mixture. Coal, coke-oven and natural gases, carbureted air and water gas are well suited for use with this type of apparatus. Disks of all sizes up to 2x2 ft. have been used.

Once the disk has become incandescent and the proportions of air and gas supplied to the mixing chamber have been properly adjusted, the surface will maintain its incandescence even in an atmosphere of carbon dioxide.

A second application of surface combustion consists in injecting the gaseous or vaporized fuel with proper combining amounts of air through a suitable orifice (at a speed greater than the velocity of combustion for the explosive mixture) into a bed of incandescent granular refractory material which is packed around the body to be heated. This is shown in Fig. 2 as worked out for a crucible furnace. While the mixture of gas and air is injected at high velocity into the base of the furnace, the active combustion is in the lowest part of the bed, and the burnt gases rise rapidly through the upper layers, maintaining the interior at a high degree of incandescence.

This process is adaptable to many other operations such as heating retorts, annealing furnaces, etc. It is not necessary that the refractory materials shall be disposed around the vessel to be heated, but they may be placed in tubes traversing the chamber to be heated. This modification is important in the melting of alloys, in heating crucibles below 600° C., and in steam boilers.

In a crucible furnace of this design, fired by coal gas, a temperature of 1880° C. was secured as shown by a Seger cone. Indeed, there was at first some difficulty in obtaining materials for the construction of muffles and crucibles which would stand the temperatures obtainable with coal, water, or natural gases. However, success was found with fragments of magnesia, which had been burned at high temperature, and with specially prepared neutral materials. Where the temperature does not exceed 1200° C., the bed of material may be a good quality of firebrick crushed and screened to suitable size.

Such furnaces are started up much as the disk heater of Fig. 1; that is, the gas is first turned on and lighted and then the air supply is opened until the flame strikes back to the orifice in the base.

To show the heating efficiency of surface-combustion devices, the results of a test on a muffle furnace are shown in the following table. The muffle was 9½ in. long by 5¼ in. wide and 3¼ in. high. Fully aërated coal gas of 450 B.t.u. per cu.ft. was used.

RESULTS OF TESTS ON A "SURFACE-COMBUSTION" MUFFLE FURNACE

| Temp. in Middle of Muffle, C. | Cu.ft. Gas per hr. for Const. Temp. | Temp. of Products of Combustion, C. |
|---|---|---|
| 815° | 21.0 | 540° |
| 1004° | 35.3 | 645° |
| 1205° | 58.0 | 870° |
| 1424° | 79.0 | 1085° |

For comparison, a similar test with a muffle of the same size, heated by flame contact in a furnace of modern design, was made. The gas consumption necessary to maintain the muffle at 1055° C., which was the maximum temperature obtainable, was 105 cu.ft. per hour. By interpolation in the above table, the combustion in the surface-combustion furnace for this temperature would have been about 43 cu.ft. per hour.

By applying this idea to gas-fired multitubular boilers, it is claimed possible to secure the absorption of nearly 95% of the energy of combustion. Fig. 3 shows an experimental boiler, of circular cross-section, traversed by steel tubes 3 ft. long and 3 in. inside diameter. These tubes were packed throughout their length

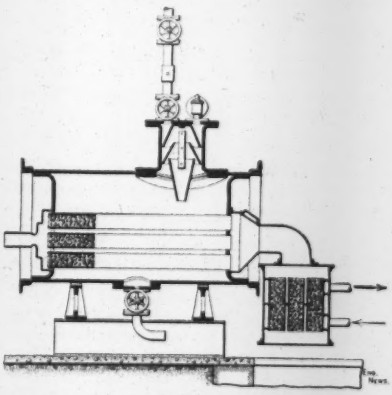

FIG. 3. AN EXPERIMENTAL 10-TUBE BOILER WITH PACKED TUBES

with fragments of refractory material. Into the front of each tube was fitted a fire-clay plug with a ¼-in. hole. This plug served to keep the front of the boiler cold and provided a suitable orifice through which the gas could be introduced at a speed high enough to prevent backfiring. It was found that the combustion of the mixture was completed before it had traversed more than 6 in. of tube. About 100 cu.ft. of coal gas, with six times that volume of air, could be fed into each tube of such a boiler. Thus in the case of the 10-tube boilers, the consumption of coal gas was about 1000 cu.ft. per hour and required about 6000 cu.ft. of air. This gives an idea of the rapid rate of flow.

It was found that the temperature of the products of combustion, after leaving the tubes, was not more than 70° above that of the water in the boiler. While this was lower than in an ordinary type of tubular boiler, yet it was considered advisable to pass the spent gases through a tubular feed-water heater constructed on the same lines as the boiler.

Tests of an experimental 10-tube boiler were made with coal gas; the mixture of gas and air being passed into the feed chamber of the boiler at a pressure of 17.3 in., water gage. The pressure of the products of combustion entering the tubes of the feed-water heater was 2 in. of water. Steam was generated at 100 lb. per sq.in., gage. The temperature of the products of combustion on leaving the boiler tubes was 230° C., while the average temperature after leaving the feed-water heater was 95° C.; water entering the feed-water heater was at 5.5° C., and it was heated to 58° C. before entering the boiler proper. The amount of coal gas sent into the boiler (corresponding to gas at 0° C. and 760 mm. pressure) was 996 cu.ft. per hour. It showed 562 B.t.u. per cu.ft., so that the total heat supplied to the boiler (and feed-water heater) was 559,800 B.t.u. per hour. The actual water evaporated was 450.3 lb. per hour. The actual heat transmitted through the water was accordingly $450.3 \times 1172 = 530{,}900$ B.t.u. per hour. The ratio of this figure to the heat of combustion in the gas burned was therefore 0.948. The average proportion of $CO_2$ in the combustion products was 10.6%, while oxygen was as low as 1.6%. Careful examination failed to show traces of CO, $H_2$, or $CH_4$.

A 110-tube boiler was recently equipped for this surface combustion at the Skinningrove Iron Works, in Cleveland, Yorkshire. This boiler is capable of evaporating 5500 lb. of water per hour, and is to be fired by gas from by-product coke ovens. The boiler is a cylindrical drum, 10 ft. in diameter and 4 ft. from front to back. It has 110, 3-in. tubes packed with fragments of firebrick. To the front of the boiler is attached a device by which gas at 2-in. gage pressure, together with the proper proportion of air, is drawn through a short mixing tube into each of the 110 tubes of the boiler. The products of combustion pass into a semi-circular chamber at the back of the boiler and then through a duct to a tubular feed-water heater. A fan attached to this feed-water heater will draw out the cooled spent gases and discharge them through a short duct into the atmosphere outside the boiler house. Under normal working conditions the steam evaporation will exceed 20 lb. per sq.ft of heating surface, which is about twice that of a locomotive boiler. It will transmit to the water something more than 90% of the net heat of combustion and can be forced to 60% higher duty with only slight drop in efficiency.

# Reinforced Concrete Regulations

**The cities of Cleveland, O., and New York, N. Y., have recently adopted official building laws for the regulation of reinforced-concrete construction. There are so few cities where the latest ideas regarding concrete are incorporated in the building regulations that these two, which are reproduced below, should be read with interest.**

## New York City

On Dec. 28, 1911, the Superintendents of Buildings of all of the five boroughs of New York City adopted a new set of building regulations for reinforced concrete to apply uniformly to all boroughs and to take effect Jan. 1, 1912. This is the first time that uniform regulations of this kind have been adopted to apply to all of the boroughs of the city. The regulations are as follows:

1. The term reinforced concrete in these regulations shall be understood to mean an approved concrete mixture reinforced by steel of any shape.

2. Reinforced concrete will be approved for all types of construction if the design is in accordance with good engineering practice and stresses are figured as required by these regulations.

3. Before permission to erect any reinforced-concrete structure is granted, complete drawings and specifications must be filed with the superintendent of buildings, showing all details of the construction, the size and position of steel reinforcement, and the composition of the concrete.

4. The concrete for reinforced-concrete structures shall consist of a wet mixture of 1 part of cement to not more than 6 parts of aggregate, fine and coarse, either in the proportion of 1 part of cement, 2 parts of sand and 4 parts of stone or gravel, or in such proportion that the resistance of the concrete to crushing shall not be less than 2400 lb. per sq.in. after hardening for 28 days.

5. Only portland cement meeting the standard specifications for cement of the American Society for Testing Materials shall be used in reinforced-concrete structures.

6. Fine aggregates shall consist of sand, crushed stone or gravel screenings, passing when dry a screen having ¼-in. diameter holes, and not more than 6% passing a sieve having 100 meshes per lineal inch. It shall be clean and free from vegetable loam or other deleterious matter.

7. Mortars composed of 1 part portland cement and 3 parts fine aggregate by weight when made into briquettes should show a tensile strength of at least 240 lb. per sq.in. at 28 days.

8. Coarse aggregate shall consist of crushed stone or gravel, which is retained on a screen having ¼-in. diameter holes and graded in size from small to large particles. The maximum size shall be such that all the aggregate will pass through a 1-in. diameter ring. The particles shall be clean, hard, durable, and free from all deleterious material.

9. Steel for reinforcement of concrete shall meet the requirements of the standard specifications for steel reinforcement of the American Railway Engineering and Maintenance of Way Association.

10. Wire used for column hoops shall be drawn from openhearth billets and shall have an ultimate tensile strength of not less than 85,000 lb. per sq.in.

11. The span length for beams and slabs shall be taken as the distance from center to center of supports, but need not be taken to exceed the clear span plus the depth of beam or slab. Brackets shall not be considered as reducing the clear span.

12. Length of columns shall be taken as the maximum unsupported length.

13. All reinforcement shall be accurately located and secured against displacement. The reinforcement for slabs shall not be spaced farther apart than two and one-half times the thickness of the slab.

14. Slabs shall not be less than 4 in. in thickness for floor and 3½ in. for roofs.

15. As a basis for calculations for the strength of girders, beams and slabs the following assumptions shall be made.

(a) A plane section before bending remains plane after bending.

(b) The modulus of elasticity of concrete in compression remains constant within limits of working stresses fixed in these regulations.

(c) The adhesion between concrete and reinforcement is perfect.

(d) The ratio of the modulus of elasticity of steel to the modulus of elasticity of concrete is 15.

(e) Concrete has no value in resistance to tension.

(f) Initial stress in the reinforcement due to contraction or expansion in the concrete is negligible.

16. The bending moment of slabs uniformly loaded and simply supported shall be taken as ⅛ Wl, where W = total load and l = span.

17. The bending moments at the center and at intermediate supports of floor slabs continuous over two or more supports shall be taken as 1/12 Wl.

18. The bending moments of slabs that are reinforced in both directions and supported on four sides and fully reinforced over the supports (the reinforcement passing into the adjoining slabs) may be taken as 1/F Wl for loads in each direction, in which F = 8 when the slab under consideration is not continuous or when continuous over one support, and F = 12 at both center and supports when the slab is continuous over both supports. The distribution of the loads shall be determined by the formula,

$$r = \frac{l^4}{l^4 + b^4}$$

in which r equals proportion of load carried by the transverse reinforcement, l equals length and b equals breadth of slab.

19. Simply supported beams shall be considered as simple beams with bending moments of ⅛ Wl.

20. Beams supported at one end and continuous at the other shall be considered as partially restrained with a bending moment of 1/10 Wl at the center and ⅛ Wl over intermediate support.

21. Beams supporting rectangular slabs reinforced in both directions shall be assumed to take the proportions of load as determined by the formula in section 18.

22. The bending moments at center and support for beams or girders continuous over two or more supports shall be taken at 1/12 Wl.

23. The bending moments due to other than uniformly distributed loads shall be computed according to accepted theory.

24. Where adequate bond between slab and web of beam is provided, the slab may be considered as an integral part of the beam provided its effective width shall not exceed on either side of the beam one-sixth of the span length of the beam nor be greater than six times the thickness of the slab on either side of the beam, the measurements being taken from edge of web.

25. Members of web reinforcement shall be so designed as to adequately take up all involved stresses throughout their entire length. They shall not be spaced to exceed three-fourths of the depth of the beam in that portion where the web stresses exceed the allowable value of concrete in shear. Web reinforcement, unless rigidly attached, shall be placed at right angles to the axis of the beam and carried around the extreme tension member.

26. Reinforced-concrete structures shall be so designed that the stresses in the concrete and steel shall not exceed the following limits.

| | Per sq.in. |
|---|---|
| Extreme fiber stress on concrete in compression | 650 lb. |
| Concrete in direct compression | 500 lb. |
| Shearing stress in concrete when all diagonal tension is resisted by steel | 150 lb. |
| Shearing stress in concrete when diagonal tension is not resisted by steel | 40 lb. |
| Bond stress between concrete and reinforcing bars | 80 lb. |
| Tensile stress in steel reinforcement | 16,000 lb. |
| Tensile stress in cold drawn steel wire used as column hooping | 20,000 lb. |

In continuous beams the extreme fiber stress on concrete in compression may be increased 15% adjacent to supports.

27. Axial compression in columns without hoops, bands or spirals, and with not less than ½% nor more than 4% of vertical reinforcement secured against lateral displacement by steel ties placed not farther apart than 15 diameters of the rods nor more than 12 in., shall not exceed 500 lb. per sq.in. on the concrete nor 6000 lb. per sq.in. on the vertical reinforcement.

28. Axial compression in columns with not less than 1% of hoops or spirals spaced not farther apart than one-sixth of the diameter of enclosed column and in no case more than 3 in., and with not less than one nor more than four per cent. of vertical reinforcement, shall not exceed 725 lb. per sq.in. on the concrete within the hoops or spirals nor 8700 lb. per sq.in. on the vertical reinforcement.

29. Axial compression in structural steel columns thoroughly encased in concrete having a minimum thickness of 4 in. and reinforced with not less than 1% of hoops or spirals spaced not more

than 12 in. apart may be taken at 16,000 lb. per sq.in. on the net section of the structural steel, no allowance being made for the concrete casing. The hoops or spirals of the concrete casing shall be placed not nearer than 1 in. from the structural steel or the outer surface of the concrete. The ratio of length to least radius of gyration of the structural steel section shall not exceed 120.

30. In reinforced-concrete columns the compression on the concrete may be increased 20% when the fine and coarse aggregates are carefully selected and the proportion of cement to total aggregate is increased to 1 part of cement to not more than 4½ parts of aggregate, fine and coarse, either in proportion of 1 part of cement, 1½ parts of sand and 3 parts of stone or gravel, or in such proportion as will secure the maximum density.

31. The vertical steel bars in reinforced-concrete columns shall bear squarely on steel plates or casting bedded on top of the footing.

32. Bending stresses due to eccentric loads shall be provided for by increasing the section of concrete or steel until the maximum stress shall not exceed the allowable working stress.

33. Whenever it is necessary to splice bars, the connections between them shall be of sufficient strength to carry the stress.

34. In columns, the splicing of longitudinals, having an area less than 1¼ sq.in., may be done by lapping, the lapped bars to be wired securely to each other. Longitudinals having areas in excess of 1¼ sq.in. shall be spliced by butting the bars squarely one over the other and tieing the same securely together by some mechanical means that will not utilize the adhesive strength of the concrete. All such splices shall be made above floor levels, but not more than 12 in. above the same.

35. In columns the ratio of length to least side or diameter shall not exceed 15, but in no case shall the least side or diameter be less than 12 in.

36. The concrete members of floor construction in which hollow tiles, concrete blocks or other fillers are used, in combination with reinforced concrete, shall be designed in accordance with these regulations, except that the slab portion cast on top of the fillers may have a minimum thickness of 2½ in. provided the fillers do not exceed 60% of the construction.

37. Exterior and interior bearing and enclosure walls of reinforced concrete, supporting floor and roof loads, shall be securely anchored at all floors, and of such thickness that the compressive stress shall not exceed 250 lb. per sq.in., but in no case less than 8 in. The thickness shall not be less than one-twentieth of the unsupported height. Steel reinforcement shall be placed near both faces of the wall, running both horizontally and vertically and weighing not less than ½ lb. per sq.ft. of wall.

38. Footings for walls and columns may be constructed of reinforced concrete provided the working stresses for concrete and steel are not exceeded and the steel is protected by at least 4 in. of concrete.

39. The steel reinforcement in columns and girders shall be protected by a minimum of 2 in. of concrete; in beams and walls by a minimum of 1½ in.; and in floor slabs by a minimun of 1 in. of concrete.

40. The contractor may be required to make load tests on any portion of a reinforced-concrete structure within the reasonable time after erection. The tests shall be made under the direction of the superintendent of buildings, and shall show that the construction will sustain safely a load of twice the live load for which it was designed.

41. These regulations do not apply to any construction for which provision is otherwise made in the building code.

## Regulations for Concrete Buildings, City of Cleveland, Ohio

Following the collapse of the Henke Building in Cleveland, Ohio, on Nov. 21, 1910,* a concerted effort was made by the building interests of the city to bring about the promulgation of a city building ordinance which would embrace the latest knowledge of the science of reinforced-concrete design and construction. Mainly as a result of this effort, an amendment to the Building Code of the City of Cleveland has recently (Dec. 13, 1911) been signed by the mayor and put into force. This amendment relates specifically to "Reinforced-Concrete Construction" and "Concrete-Block Construction" and governs all building work where concrete is used.

We reproduce below the larger part of the "Reinforced-Concrete Construction" portion of the ordinance. It is particularly complete and in sharp distinction to the loose official rules on concrete that have been in vogue in Cleveland and are still in effect in most municipalities. Particular note should be taken of the moment provisions, the flat-slab rules, the sections on hooped columns and the mandatory provisions for a competent inspector on every job.

### REINFORCED-CONCRETE CONSTRUCTION

DEFINITION—By reinforced concrete is meant concrete in which steel is embedded in such a position that it shall resist all tensile stresses and assist in the resistance of shear along proper structural lines so that the stresses in the combination can be ascertained by computation and verified by tests.

The concrete shall be mixed in such proportion and so handled that after it is placed in the forms, all voids in the aggregate will be filled with mortar and all voids in the mortar filled with cement. Thirty days after mixing, it shall develop a crushing strength of 2000 lb. per sq.in. by testing a 6-in. oube.

DRAWINGS—Before a permit shall be issued for a reinforced-concrete building or structure, complete working drawings, details and specifications shall be filed with the Department of Buildings, giving the size and location of members, the size and position of reinforcing rods, stirrups, bent rods and any other information necessary for the proper calculation of the structure or building. The Department of Buildings reserves the right to demand that the owner, architect or engineer submit a certified copy of such computation or stress sheets for examination upon application for a building permit.

The Department of Buildings in granting a permit to erect any reinforced-concrete structure does not in any manner pass the construction until after tests have been made of the actual construction to their satisfaction.

UNIT STRESSES—The following unit working stresses shall not be exceeded:

| | |
|---|---|
| Iron in tension | 12,000 lb. per sq.in. |
| Medium steel in tension | 16,000 lb. per sq.in. |
| High carbon steel in tension | 18,000 lb. per sq.in. |
| Cold twisted medium steel in tension | 18,000 lb. per sq.in. |
| Steel to resist diagonal tension | 10,000 lb. per sq.in. |
| Concrete in direct compression | 500 lb. per sq.in. |
| Concrete in direct compression (spiral reinforced columns) | 650 lb. per sq.in. |
| Concrete—Extreme fiber in compression (As determined by the straight-line formula.) | 700 lb. per sq.in. |
| Bond stresses for plain high-carbon bars | 70 lb. per sq.in. |
| Bond stresses for plain low-carbon bars | 50 lb. per sq.iin. |
| Bond stresses for twisted or deformed bars | 100 lb. per sq.in. |
| Concrete in diagonal tension | 40 lb. per sq.in. |

(Note—The compressive stress in the steel shall not exceed the product of the compressive stress in the concrete multiplied by the elastic modulus of the steel and divided by the elastic modulus of the concrete.)

SLABS, BEAMS AND GIRDERS

All reinforced-concrete work shall be designed in accordance with standard engineering practice and the following assumptions:

That the ratio of moduli of elasticity of concrete to steel is 1 to 15. That the adhesion of the concrete to the steel makes the two materials act together. That tensile stresses are taken by the steel and that the stress-strain curve of concrete in compression is a straight line.

Beams, slabs and girders shall be calculated as continuous unless constructed so as to act as simple beams. When continuous for uniform loads, the bending moment at the center shall be figured as not less than $W l^2 \div 10$ for the intermediate spans and $W l^2 \div 9$ for the end spans, provided at least 66% as much reinforcement is provided at the top over supports as at the center of the member, and the reinforcement extends beyond the support a sufficient distance to insure proper bond.

In all cases, however, beams and girders which are built monolithic at the supports shall have at least 20% as much steel in the top over supports as at the center. For concentrated loads on continuous beams or girders, the bending moment at the center shall be calculated as for a simple beam, and this moment may be reduced 20% for intermediate spans or 10% for end spans.

Where a short span adjoins a long span and one-half of the short span considered as a cantilever cannot produce a bending moment which will develop the strength of the reinforcement over

*See Engineering News, Vol. 65, Jan.-June, 1911; a number of articles in various issues.

the supports, the long span shall be considered as an end span.

For simple girders, beams or slabs the span shall be taken as the clear span and for continuous girders, beams or slabs, the span shall be taken as the distance between centers of supports.

T-BEAMS—When beams are made monolithic with the floor slab a portion of the floor may be assumed as acting in flexure in combination with the beam.

The width of the slab so acting in flexure is to be governed by the shearing resistance between slab and beam, but limited to a width equal to one-third of the span length of the beams between supports and also limited to a span length of three-quarters of the distance from center to center between beams.

No part of the slab shall be considered as a portion of the rib, unless the slab and rib are cast at the same time.

Where reinforced-concrete girders support reinforced-concrete beams, the portion of the floor slab acting as flange to the girder must be reinforced with rods near the top, at right angles to the girder, to enable it to transmit local loads directly to the girder and not through the beams.

WEB STRESSES—Where the diagonal tension exceeds 40 lb. per sq.in., additional web reinforcement of approved design shall be used.

Stirrups shall not be placed further apart than two-thirds if they are considered as adding to the shearing resistance. In no case shall the shear exceed 125 lb. per sq.in.

When reinforcement is used to increase the unit shear, the proportion of the unit shear taken by the concrete shall not exceed 40 lb. per sq.in., and the reinforcement shall be sufficient to take the remainder. If unattached stirrups are used they shall pass under the main reinforcing bars.

There shall be sufficient anchorage to develop the stirrups above the neutral axis of the beams without exceeding the bond stresses specified. If the stirrups are attached to the reinforcing bars the connection must be sufficient to develop the elastic limit of the steel without causing slipping along the main bars.

If the reinforcing rods are bent up approximately 45° and are spaced no further apart than "d," where "d" equals the effective depth, or if the bars are bent at the quarter points, they may be figured as shear members in providing for the excess shear over 40 lb. per sq.in.

RECTANGULAR SLABS—For square slabs with two-way reinforcements, the bending moment at the center of the slab shall not be less than $W\ l^2 \div 20$ for intermediate spans, and $W\ l^2 \div 18$ for the end spans.

The moment over supports shall be not less than $W\ l^2 \div 30$, and the sum of the moments over one support and at the center of the span shall be taken not less than $W\ l^2 \div 10$, in which above formula "W" is the load per linear foot and "l" the length of span.

For square or rectangular slabs the distribution of the loads in the two directions shall be inversely as the cubes of the two dimensions.

FLAT SLAB CONSTRUCTION—The type of construction referred to in this section is a design of reinforced-concrete slab supported by reinforced or structural-steel columns with flaring heads and in which beams and girders are eliminated.

This construction shall be figured with a bending moment in any quadrant over the column head of not less than $\frac{W\ l^2}{27}$ in foot-pounds, in which W equals total weight per square foot, dead and live load, and l equals length in feet of a side of an equivalent square in rectangular panels and the side of a square in square panels. This length shall be taken center to center of columns. In calculating the required area of steel in each band at the center of the span, the length of span of band shall be taken center to center of columns in the above formula. The bands of reinforcement shall be made approximately $\frac{1}{6}$ l in width. In solving for the required area of steel over the column head, the distance from the compressive face to the plane of steel assumed shall be from the center of gravity of all the steel to the under side of slab. Any additional steel required over the column head shall extend beyond the center of column a distance not less than 0.3 l in all directions.

The radial bars may be assumed as resisting tension provided they are carried a distance horizontally not less than 0.1 l each way before bending downward; further, that the allowed area of each radial bar figured to resist tension shall constitute not over one-half the area of any single band of continuous reinforcement.

The diameter of interior spirally reinforced concrete columns shall never be less than $\frac{1}{13}$ for floors, or $\frac{1}{14}$ for roofs and the diameter of column head shall never be less than 0.2 l, and this head, if constructed of concrete, shall be dropped below the under side of slab at least 3 in. at the outer edge.

Rectangular panels shall never be less in thickness than $\frac{1}{30}$ diagonal distance from center to center of columns, for floors, and not less than $\frac{1}{35}$ for roofs.

The minimum thickness of slabs shall be 6½ in. for floors and 6 in. for roofs.

The required percentage of steel in a single layer of bars shall not exceed 0.44% for medium steel, or 0.36% for high-carbon steel. In any flat slab type of construction provision shall be made to take care of circumferential stresses.

In end or wall panels in which wall columns of reinforced concrete with heads are omitted, allowance shall be made for the increased moments. These moments shall be assumed to be 10% greater than the moments in the interior panels.

If wall columns are used they shall be calculated to carry one-half the panel load plus any other loads and, if necessary, the column shall be designed for eccentric loadings. The wall beams shall be designed to carry one-third of the panel load plus any other loads. The minimum width of wall beams of reinforced concrete shall be 12 in., and never less than one-half the depth of beam.

MINIMUM THICKNESS OF SLABS—Reinforced-concrete slabs shall not be less than 4 in. thick for floors and 3 in. for roofs.

## COLUMNS

In all buildings hereafter to be erected all interior columns shall have spiral and vertical reinforcement, or shall have columns built of structural steel encased in concrete, and the slab steel shall be so placed that it comes near the top of slab at the columns and shall be held firmly in position in such a manner that the bars cannot be displaced. A spacing and clamping device satisfactory to the Department of Buildings shall be used for the floor slab steel.

Reinforced-concrete columns shall not exceed in length 15 times the least side or diameter, and where such columns exceed 12 times the least diameter or side, the allowable compression of the concrete shall be taken as 500 lb. multiplied by the least side or diameter of the column in inches and divided by the unsupported length in feet.

For columns subject to eccentric loading or bending of an indeterminate amount, the above stress shall be reduced at least 20%. When the bending stresses in a column can be definitely determined, the combined bending and direct stress shall not exceed 500 lb. per sq.in.

Columns with longitudinal rods shall have at least 1 sq.in. of steel in the total area and not less than four rods; and rods shall not be used of a less diameter than ½-in. The area of the longitudinal rods shall not be less than 0.5% of the required cross-section area of the column and shall not exceed 4% of the effective cross-sectional area of the column. The longitudinal rods must be tied together to resist outward flexure at intervals not greater than the least width or diameter of column.

The steel hoops shall not be less than ¼-in. diameter and spaced not more than 12 in. apart.

SPIRAL REINFORCEMENT—Where the reinforcement consists of vertical bars and spiral hooping, the concrete shall not be stressed beyond 650 lb. per sq.in., provided that the amount of vertical reinforcement be not less than the spiral reinforcement nor greater than 5% of the area within the hooping; that the percentage of spiral hooping be not less than 0.5%, and not to exceed 1.5%; that the pitch of the spiral be uniform and not greater than one-eighth of the diameter of the column, nor greater than 3 in.; that the spiral be secured to the verticals at every intersection to insure the maintaining of its form and position; that the verticals be spaced so that their distance apart, measured on the circumference, be not greater than 9 in., or one-eighth the circumference of the column within the hooping. In such columns the action of the hooping may be considered equal to 2.4 times its amount taken as vertical reinforcing. No part of the concrete outside of the hooping shall be considered as a part of the effective column section.

STEEL COLUMNS ENÇASED IN CONCRETE—Where structural-steel columns in steel-frame structures or structures in which the loads are transmitted directly to steel column, are encased in concrete, the structural steel shall be proportioned to carry the total dead load and fifteen-sixteenths of the total live load that can be transmitted to same and the concrete shall be proportioned to carry one-sixteenth of the live load only; and in no case shall the unit stress in the structural steel exceed 16,000 lb. per sq.in. of net steel section, or shall the unit stress in the concrete exceed 500 lb. per sq.in. of net concrete section.

In columns of this design the concrete shall be reinforced with spiral hooping of not less than 0.5%.

The pitch of the spiral shall be uniform and not greater than one-tenth of the diameter of the hooping nor greater than 3 in. The spirals shall be secured at each intersection in such a manner as to insure the maintaining of its form and position.

No part of the concrete outside of the hooping shall be considered as a part of the effective column section.

In latticed or open web structural columns it shall not be necessary to use the hooping specified above.

In buildings with columns of this design the height shall be limited to 16 stories or 200 ft. in height, provided that the other requirements of this code for buildings of this height are complied with.

All structural steel which is to be encased in concrete shall be wrapped with wire in such a manner as to insure the bonding of the concrete to the steel, and no structural steel which is to be encased in concrete shall be painted or oiled. Before encasing structural steel in concrete, scale or rust of any appreciable amount shall be removed.

SPLICES—In all buildings hereafter to be erected the column splices shall be made in such a manner as to transmit the stresses for which they are designed. The connections shall be made by turnbuckle, sleeve nut, slip sleeve, or by lapping the rods and bolting together in such a manner that the stresses will be transmitted properly. If the device used requires the rod to be threaded the effective area shall be taken at the root of the thread. If a slip sleeve is used the rods must have their ends milled or equal. The diameter of the sleeve to be not over one-sixteenth inch larger than the diameter of the rod. Where the bearing is made metal to metal the contact shall be made so as to transmit all stresses properly. Where the rods are in tension due to wind stresses the connection shall be made by means of a positive connection. The use of pipe-sleeve connections is prohibited, unless they fit the rods as above described. All column steel shall set directly in line with the steel below and must be constructed in such a manner as to eliminate any short bends in the steel. The steel reinforcement shall be spliced at such a point above the floor that the bond stress in the rod is developed enough to carry the increased load transmitted to it.

## CURTAIN WALLS

Buildings having a complete skeleton construction of steel or of reinforced-concrete construction, or a combination of both, may have exterior walls of reinforced concrete 8 in. thick, provided, however, that such walls shall support only their own weight, and that such walls shall have steel reinforcement of not less than 0.3% in each direction vertically and horizontally, the rods spaced not more than 12 in. centers and wired to each other at each intersection. All bars shall be lapped for a length sufficient to develop their full stress for the allowable unit stress for adhesion. Additional bars shall be set around openings, the verticals wired to the nearest horizontal bars, and the horizontal bars at top and bottom of openings shall be wired to the nearest vertical bars.

The steel rods shall be combined with the concrete and placed where the combination will develop the greatest strength, and the rods shall be staggered or placed and secured so as to resist a pressure of 30 lb. per sq.ft., either from the exterior or from the interior on each and every square foot of each wall panel.

## FIREPROOFING

For the purpose of fire protection the outer surface of reinforcing steel shall be kept away from the surface of the concrete 2 in. in columns and girders, 1½ in. in beams and ¾ in. in slabs.

No reinforcing steel not protected from fire shall be considered as adding to the strength of the construction.

Lime or hard wall plaster shall not be considered as a fireproofing material in reinforced-concrete work.

## PROPORTION FOR CONCRETE

All reinforced concrete shall be mixed in the proportion of one part portland cement to two parts clean, sharp sand and not more than four parts aggregate. Where slag or other similar material is used the proportion of aggregate shall be reduced in order to have the voids properly filled. In no case shall more than two parts sand be used to one part cement, and all mixing shall be done by machine, except where limited quantities are required, or where the conditions of the work make hand mixing preferable; hand mixing to be done only when approved by the Department of Buildings. In all mixing the separate ingredients shall be measured and shall be thoroughly mixed and must be uniform in color, appearance and consistency before placing.

## MATERIAL

CEMENT—Only portland cement shall be used which conforms to the standard specifications of the American Society for Testing Materials.

SAND—The sand used shall be clean, coarse, sharp, natural sand, preferably a mixture of coarse and fine grains with the coarse grains predominating. The maximum percentage of clay or loam shall not exceed 5%, and at least 60% shall be retained on a 50-mesh sieve, and the sand shall contain at least 90% silica.

AGGREGATE—The aggregate shall consist of hard, broken stone, free from dust, clean gravel, slag or similar material crushed and screened to pass a 1-in. ring and rejected on a ¼-in. ring.

STEEL—All steel shall be tested by an approved testing laboratory, and the Department of Buildings may, at any time, demand that certified copies of all test records be submitted to it for examination. All steel used for reinforcing purposes shall comply with the "standard specifications" governing the chemical and physical properties of concrete-reinforcing bars as adopted by the Association of American Steel Manufacturers, 1910, with the following modifications:

All reinforcing steel not rolled from billets shall be rolled from standard section T-rails, and shall comply with the physical tests specified in Paragraph 2 of the above mentioned standard specifications. A complete physical test shall be made, by an approved testing laboratory, of each size of bar to be applied by the manufacturer on the contract from each 10-ton lot or less.

Hot twisted bars, of high-carbon steel, shall be twisted with one complete twist in a length equal to not more than 12 times the thickness of the bar.

The Department of Buildings may demand the owner, builder, contractor, subcontractor or foreman to make, or cause to be made, bending tests in the field, on all grades of reinforcing steel, when in their opinion there is any doubt as to whether the reinforcing steel is up to the standard of these regulations.

These bending tests shall be those specified in the above mentioned "standard specifications."

## PLACING CONCRETE AND STEEL

In filling in concrete around reinforcing steel, the concrete must be worked continuously with suitable tools as it is put in place. Filling the columns completely and puddling afterward will not be permitted. In placing the concrete the work shall be so laid out that partially set concrete will not be subjected to shocks from men wheeling or handling material over it. Concrete placed in warm weather shall be drenched with water twice daily, Sundays included, during the first week after being put in place.

When it is not possible to cast an entire structure in one operation, the work should be stopped; for columns at the underside of girders; for girders at a point midway between supports, unless a beam should occur at this point, in which case the joint should be offset a distance equal to twice the width of the beam; for slabs at the center of the span.

When work is resumed the concrete previously placed shall be cleared of all foreign material, drenched and slushed with a mortar composed of one part cement and one part sand.

Beams and girders shall not be constructed over freshly placed columns without permitting a period of 10 hours to elapse to provide for settlement of shrinkage in columns.

Before resuming work the top of the column shall be cleansed of foreign matter, and if the column has become hard, the top shall be wet and slushed with the cement grout above specified.

When beams are designed as T-beams, the slab shall be poured at the same time as the web.

Some means satisfactory to the Department of Buildings shall be used to hold the reinforcing steel in its proper position by means of a spacing and clamping device.

The longitudinal steel in beams and girders shall be so disposed that there shall be a thickness of concrete between the separate pieces of steel of not less than 1½ times the maximum sectional dimensions of the steel.

When steel is used in the compressive side of beams and girders, the rods shall be tied in accordance with requirements of vertical reinforced columns, with stirrups connecting with the tension rods of the beams or girders.

## FREEZING WEATHER

When concrete is placed in freezing weather, the materials must be heated and such provisions made that the concrete can be put in place without freezing.

The use of frozen, lumpy sand or aggregate depending on hot water used in mixing to thaw it out, will not be permitted. All reinforced concrete shall be kept at a temperature above freezing for at least 48 hours after being put in place. All forms under concrete placed in freezing weather shall remain until all evidences of frost are removed from the concrete and the natural hardening of the concrete has proceeded to the point of safety.

## CENTERING AND FORMS

All forms shall be built in a substantial manner, plumb and true, with tight joints, so that no appreciable part of the concrete mixture can escape, and shall be so supported and braced that they will carry all the usual loads which may come upon them without springing or deflection.

An opening shall be left at the bottom of all column forms for cleaning and adjusting the steel. This opening shall not be closed until all is in readiness for pouring the columns. The forms shall be carefully cleaned just before concreting, and all chips, ice and other foreign matter removed.

Before removing the shores under any beam or girder the columns supporting it shall be stripped so that the columns may be examined on all sides. Pouring columns in chases left in the masonry shall not be allowed.

Provided ample shores are used to carry the full weight of the floor, column forms may be removed in not less than four days after pouring.

The time which shall elapse before removing the shores under beams and girders varies with the design and condition of the weather, but in no case shall they be removed in less than three weeks after pouring, provided that the beams and girders carry their own weight only. Where beams and girders carry construction loads from above, sufficient shoring shall be left in place to carry these loads until the completion of the work.

The supports under floor slabs shall not be removed in less than 10 days after pouring, but this clause is not intended to prevent removing the joists and lagging in less time, provided the slabs are kept properly shored up.

### INSPECTION AND TESTS

When any reinforced concrete is used in construction, the owner shall provide for the inspection of cement and inerts, as required by the Inspector of Buildings. Unless otherwise authorized in writing by the Inspector of Buildings, the owner shall also provide a special inspector of the work who shall be satisfactory at all times to the Inspector of Buildings, and who shall be on the work continually during the mixing and the placing of concrete and steel and the removal of forms. Such special inspector shall make daily written reports to the Inspector of Buildings on the progress of the work.

Before reinforced-concrete work is started, the owner shall name in writing the special inspector, and such special inspector shall pass such examination as may be required by the Inspector of Buildings to determine his competency.

Before a building containing reinforced-concrete floors is occupied, the floors shall be tested by applying a load equal to two and one-half times the figured live load to such parts as the Inspector of Buildings or deputies may select. The floor shall sustain this load for at least 24 hours, without cracking or other evident signs of failure.

## Mexican Asphaltic Fuel-Oil for Locomotives*

By R. Godfrey Aston†

In August, 1911, the Tehuantepec National Ry. Co. received the first cargo of a native or Mexican fuel-oil under a contract with the Campañia Mexicana de Petroleo, of El Aguila, at a price of $1.75 (Mexican) per barrel of 42 U. S. gal. delivered into the railway company's tanks at Puerto Mexico. This oil, which is used in its crude state as fuel, is jet black in color, thick, and has a heavy asphalt base. Although the company has not used it sufficiently long to be able to compare it with the Texas oil [the ordinary locomotive fuel], it may be of interest to state a few of the difficulties met with when first the company began to use it.

FUEL OILS ON THE TEHUANTEPEC NATIONAL RY., MEXICO

| | Mexican Oil | | Texas Oil | |
|---|---|---|---|---|
| | No. 1 | No. 2 | No. 1 | No. 2 |
| Specific gravity @ 60° F. | 0.944 | 0.942 | 0.931 | 0.88 |
| Baume gravity @ 60° F. | 18.4° | 18.8° | 20.5° | 29° |
| Flash-point (closed) | 78° F. | 102° F. | 130° F. | 135° F. |
| Flash-point (open) | 104° F. | 120° F. | 160° F. | 160° F. |
| Fire test | 165° F. | 180° F. | 220° F. | 224° F. |
| Setting point | ..... | ..... | 3° F. | 20° F. |
| Viscosity* @ 100° F. | 1,080 sec. | 920 sec. | 200 sec. | 78 sec. |
| Sulphur | 3.44% | 3.35% | 0.77% | 0.26 |
| Calorific value (calories) | 10,971 | 10,610 | 10,688 | 11,000 |
| Color | Black | Black | Dark brown | Dark Brown |
| Water† | nil. | 0.5% | 1%† | 0.25%† |
| Asphalt | ..... | 37% | ..... | ..... |
| Carbon (coke) | ..... | 12% | ..... | ..... |

*Viscosity by Redwood system. †Water and dirt for Texas oil.

As this oil is thicker than Texas oil, heaters have to be used in the engine tanks, but it has been found that if this oil is heated up to about 150° F. (which can be done with Texas oil), great difficulty is experienced in getting the burner spray to light. The oil settled very thickly at the bottom of the tank; it would not run through the pipes to the burner, and could only be burned effectively by mixing a fresh supply of oil with it. In order to burn this Mexican oil successfully, it requires to be only just warmed.

When using this, a large piece of carbon or cokelike substance is formed in the firebox, and grows up from the bottom of the pan or grate directly under the burner mouth. This may vary from 6x4x4 in. to 12x10x8 in. in size, growing up in such a manner as almost to smother the burner mouth. The analysis of this substance is as follows: Ash, 1.25%; sulphur, 7.89%; carbon, 90.86%. It shows to a certain extent that there is incomplete combustion, which can be remedied by admitting more air; but this cannot very well be done without affecting the steaming qualities of the engines. However, by raising the burner slightly these lumps of carbon have decreased in size, and it is hoped eventually to adjust things in such a manner as to prevent their forming at all.

The analyses of two cargoes of this Mexican oil are given in the accompanying table [to which we have added the analyses of the Texas oil, as given elsewhere in the paper.—Ed.]. It may be explained that the 37% asphalt is obtained by distilling off the distillates from the crude until only 37% residue is left, which consists of asphalt. The 12% coke is obtained by distilling this 37% down to 12% residue (on the crude). So that if they get 37 % asphalt, they do not get the 12% coke, and if they get the 12% coke, they do not get the 37% asphalt. The standard temperature for the measurement of fuel-oil is 60° F. Expansion is allowed for at the rate of 1% for every 20° F. increase in temperature above 60° F., and contraction at the same rate for decrease in temperature below 60° F.

[The standard fuel for locomotives on this railway is Texas oil, brought in tank steamers or barges to Puerto Mexico. It is pumped through an 8-in. pipe to three storage tanks, the two largest of which are 1¼ miles from the wharf. Figures given in the paper show that for eight months in 1911 the Texas oil averaged $1.99 (Mexican) per bbl., or 17-16c. per engine mile, while the distance run per barrel of oil was 5.52 miles. An abstract of a paper on "Petroleum Fuel for Locomotives on the Tehuantepec National Ry., Mexico," by Louis Greaven, will be found in Engineering News, Aug. 9, 1906.—Editor.]

*From a paper presented to the Institution of Mechanical Engineers (London), Dec. 15, 1911.

†Rincon Antonio, Oaxaca, Mexico.

**What the College-trained Engineer** needs—It was the engineer-in-chief of a great modern undertaking requiring the combined efforts of civil, mechanical and electrical engineers, and of a big labor army with many officers graduated only in the school of experience, who expressed his desire for and belief in the ultimate supremacy of the college man as an executive.

At the same time he frankly stated that, where one college graduate had failed him for lack of technical attainments, nine had disappointed his expectations for other reasons. Some failed owing to inability to discipline themselves, and many others did not properly supervise, use and coöperate with those under their control. Some did not realize that the engineer is no longer any man who can merely subdue or adapt natural forces and materials to the needs of civilization. Not a few can now solve satisfactorily the purely mechanical side of problems; but the successful engineer is the man who, in addition to this, can make the dollar go farthest and draw out the best efforts of his workmen.

There are, the writer believes, several educational causes for failure and discouragement which might be removed. The first of these is neglect of general culture prior to the college course. This is a marked defect in our present high-schoo- system, and also in all the "get-wise-quick" schemes of a semi-scholastic nature for "framing up" an engineer. This neglect is followed too often—and even encouraged at some colleges—by options and by too early specializations, which frequently remove the last chance the young engineer has of laying the foundation of an all-round mentality. No young graduate should now be allowed to leave college in total ignorance of the large extent to which knowledge and study of the human factor bulk in executive success.—John Calder, in the "General Electric Review."

## A Heating Attachment for Concrete Mixers

With the extending use of asphaltic and bituminous concrete paving, concrete-mixing machines have been utilized for the preparation of these materials on the work. This necessitates the application of some form of heating system to the mixer drum in order to dry the stone and to maintain the necessary temperature for softening and mixing the materials. Such a heating system may be used also in making concrete during cold weather. In some cases, heat has been applied to the exterior of the drum, but the accompanying cuts represent a mixing machine in which the heat is applied to the interior, where it acts directly upon the contents. Fig. 1 shows a complete portable mixer plant with the heater attachment. In this case, steam is the motive power, but the plant can be operated equally well by a gasoline engine or electric motor.

On the frame of the machine is mounted an air compressor *A* with cylinder 4½x6 in.; this is belted to the main engine (or motor). The air is delivered to the top of the receiver *B*, which forms a tank for both air and oil; the capacity is 48 gal. and the normal supply of oil is 32 gal. The air pressure above forces the oil out through a pipe which extends to the bottom of the tank, thus preventing air bubbles in the oil. Two 1¼-in. hose pipes *C* and *D* deliver oil and air, respectively, to the burner or atomizer of the combustion chamber *E* which is placed beneath the charging hopper *F;* this chamber is a steel box with firebrick lining. The flame from the burner is blown across the chamber, and at the rear of the chamber is an air-blower which diverts the flame and drives it forcibly through an opening which registers with the charging opening of the drum *G*. This blower is fed by a small hose pipe *H* which is connected to the main air pipe back of the burner. The combustion chamber is practically a part of the charging hopper, and tilts with the motion of the mixer drum.

The details of the heater are shown in Fig. 2. The oil and air pipes unite at the burner and the flame is regulated by a single needle valve *J*, so as to obtain the desired intensity of heat. The outlet of the burner is so formed as to give the flame a whirling motion in the chamber so that it does not reflect directly back upon the burner from the opposite wall. The air jet from the blower *H* strikes the firebrick lining of the combustion chamber and is deflected downward to the nozzle opening, causing a sharp current which delivers the flame into the drum. The material in this revolving drum falls through this zone of heat.

When the machine is in use for making paving composition, the stone is first charged into the drum and in a few minutes is dried and heated; the asphalt is then added and the materials are mixed and heated simultaneously. With a charge consisting of 9 cu.ft. of broken stone and 10 gal. of liquid asphalt, a batch could be delivered in about three minutes when the stone was thoroughly dry before being charged into the machine. With stone that was very wet, a batch could be delivered in five minutes; in this case the stone was thoroughly dried and was too hot to be held in the hand before the asphalt was charged into the drum. The heater can be attached to machines already built, and it is an easy matter to learn how to adjust the burner to meet the desired conditions. It is stated that tests show that there is no liability of setting fire to the mixture. A modified form of heater has been designed, in which the air blower is dispensed with, the burner being placed at the rear of the chamber (in approximately the position of the air blower shown in Fig. 2) and blowing the flame directly forward to the mixer drum.

The device is the invention of M. Rosendahl, of the Municipal Engineering & Contracting Co., of Chicago, and is manufactured by this company.

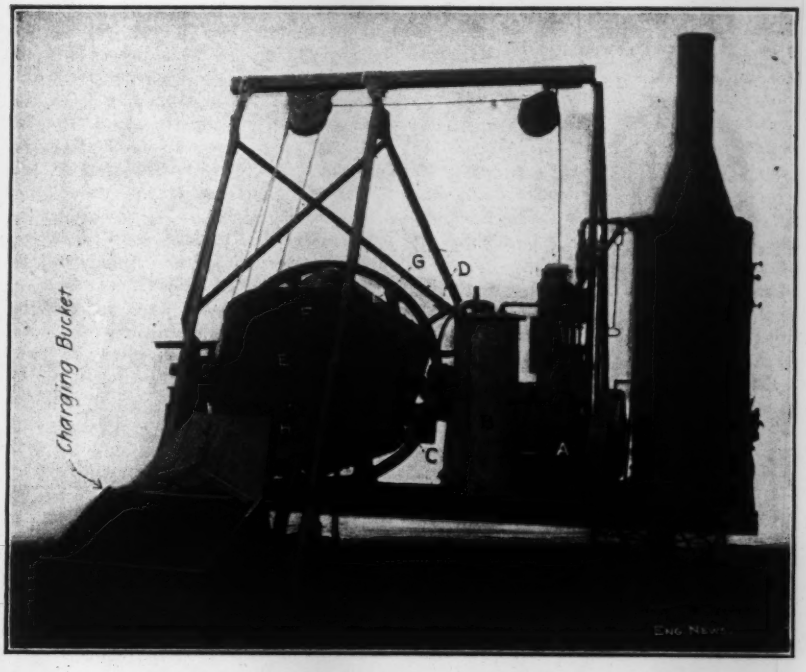


FIG. 1. CONCRETE MIXER WITH HEATER ATTACHMENT FOR USE IN MIXING BITUMINOUS COMPOSITIONS FOR PAVING, ETC.
(Municipal Engineering & Contracting Co., Chicago; Builders)

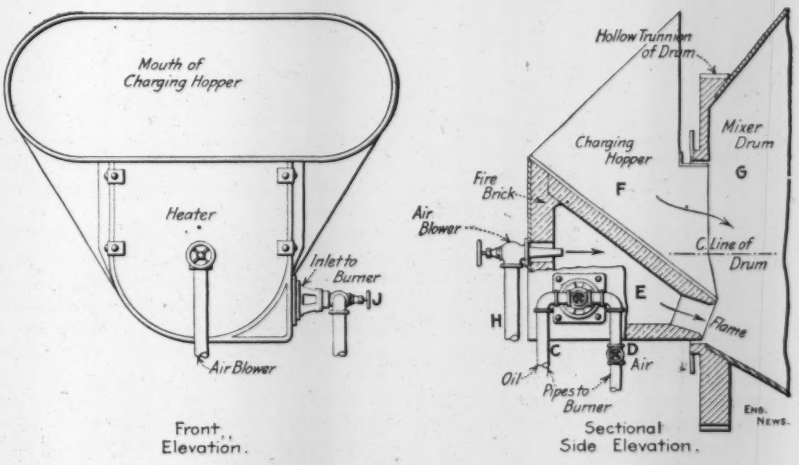


FIG. 2. HEATER ATTACHMENT FOR CONCRETE MIXERS

# Removing the Old Standpipe in the Chicago Avenue Pumping Station: Chicago

By F. Carl Martini*

The Chicago Ave. pumping station is the oldest one of the eight stations now pumping the water supply of the city of Chicago. An ornamental tower, built in 1860, inclosing a steel standpipe, forms one of the landmarks of the city.

The standpipe in the tower was cylindrical in shape, approximately 36 in. internal diameter and about 138 ft. high; it was made of ½-in. wrought-iron plates

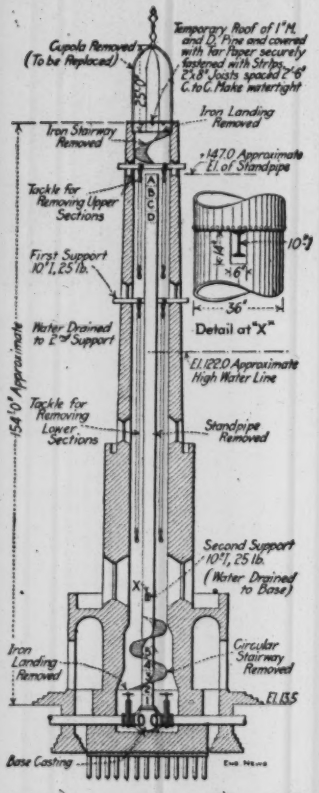
Cupola Removed (To be Replaced)
Temporary Roof of 1" Mt. and D. Pipe and covered with Tar Paper securely fastened with Strips 2"x 8" Joists spaced 2'-6" C. to C. Make watertight
Iron Landing Removed
Iron Stairway Removed
+147.0 Approximate El. of Standpipe
Tackle for Removing Upper Sections
A B C D
First Support 10"I, 25 lb.
10'-7"
Detail at "X"
Water Drained to 2nd Support
El. 122.0 Approximate High Water Line
154'0" Approximate
Tackle for Removing Lower Sections
Standpipe Removed
Second Support 10"I, 25 lb. (Water Drained to Base)
Iron Landing Removed
Circular Stairway Removed
El. 13.5
Base Casting
Eng News

Fig. 1. Cross-section of Water Tower and Standpipe at the Chicago Ave. Pumping Station (Chicago), Showing Method of Removing Standpipe

for the lower part, diminishing to ⅛ in. toward the top. It rested upon a heavy base casting which not only acted as a base for the standpipe but also as an equalizer or header for six 28-in. radiating water mains leading both to the station and to various supply pipes and for the standpipe itself. There were gate valves on each of the 28-in. mains close to the above mentioned casting so that water could be shut off from the standpipe.

A spiral cast- and wrought-iron stairway wound about the standpipe and was supported at intervals on the standpipe and on the brick wall of the tower. At the foot of the spiral stairway and at the top level wrought-iron platforms entirely surrounded the standpipe. On the masonry tower, which is about 154 ft. high and 10 ft. internal diameter, there was a cupola which served as a lookout.

A recent investigation disclosed the circular steel shell and stairway to be badly rusted and in dangerous condition, and it was decided to remove them. While past experience has shown that a system as large as Chicago's does not require standpipes, the connecting casting could not well be done away with. It was, therefore, decided to remove the standpipe and cap the base casting with a blind flange.† The general arrangement is shown in Fig. 1. It may be noted that while the interior of the standpipe was badly rusted there appeared to be no serious corrosion of the metal except at the top, near the average water line. Here the corrosion was very marked and several holes had been eaten through the plates. It is reported that one contributing cause for this may have been a practice indulged in at one time of purposely admitting air to the pumps in order to show an apparent increase in water pumped. The entrained air and the consequent foaming may have tended to increase the normal corrosion.

The work was performed in the following manner: The drilling of the 36 one-inch holes in the new flange, to fit those in the old casting, proved an interesting problem, as no plans of the old work existed, and the demands of the water supply prohibited the shutdown which would be caused by drilling the holes in the field after the removal of the standpipe.

The template for the bolt circle was made on the assumption that the centers of the bolt heads corresponded to the centers of the bolts. The bolts had been irregularly spaced, the heads were apparently hand-forged, and were badly rusted.

A flat surface was filed on each bolt head, and with the aid of a hermaphrodite caliper the center was determined and marked with a fine center punch. The bolts were then numbered. The spacing in each case was gaged with sharp steel dividers and transferred directly, without scaled measurement, to the paper of a field book with a small steel plate as backing. The distances were afterward measured and summed up to serve as a guide in determining the diameter of the full-sized trial-bolt circle to which the bolt spacing was again transferred without scaled measurement. The average spacing considered as one side of a 3[illegible] sided figure gave a circumference four[illegible] to be correct to 1/50 in. on the first tria[illegible] The holes were drilled 1⅛ in. diameter and were later found to match those i[illegible] the old casting by using 33 one-inch bolts and three ⅞-in. bolts (Fig. 2).

After the blind flange had been de[illegible]livered at the site, the six valves were closed and the pipe was drained and temporarily suspended from beams in the upper part of the tower. The bottom was then cut out with an oxyacetylene torch, and the flange placed on the casting. It is of interest to note that at time of cutting the metal the water had not

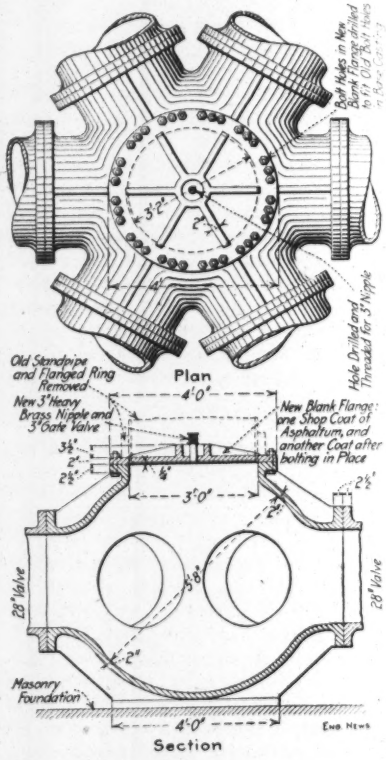


Fig. 2. Base Casting of Standpipe (Forming Pipe Connections), with New Cover Put in Place After Disconnecting the Standpipe

all been drained out of the pipe. There was a small head of water against the point where the cut was made, but this did not appear to affect the action of the flame in any way, the water oozing out of the cut immediately behind the flame. The entire operation, including closing of valves, draining and cutting pipe, and placing of flange, covered about five hours.

The plan adopted for suspending the standpipe with its lower portion removed, was to cut two sets of holes about 6x14 in. just opposite windows in the tower at elevations of about 48 ft. and 128 ft. respectively. At each of these points a

*Assistant engineer, department of public works, Chicago.

†The tower is to be preserved as an interesting landmark, and on account of its historical associations and its architectural design. Some of the masonry is defective, but this will be repaired, all cracked stones being replaced, as has been done at the Chicago Ave. pumping station.—Ed.

10-in. I-beam was passed through the windows and the openings in the standpipe, so that the beams rested on the window sills and the pipe rested on the beams. The second course or section of the pipe (from the bottom) was then cut out by the oxyacetylene process, and the bottom section was hoisted out and removed from the tower to allow of placing the new flange. After this flange was in place, other bottom sections were cut out in the same way. Afterward, the top sections were cut out and lowered. Each section weighed about 1500 to 2000 lb. The tackle used in handling the sections was attached to the upper I-beam.

The work of removal was done under the supervision of H. W. Clausen, engineer of water-works construction for the city of Chicago, with L. L. Hunter, assistant engineer, in direct charge. The contractor was John J. Gallery.

## A Heater Utilizing the Hot Gases Exhausted from a Gas Engine

The exhaust gases from gas, gasoline or oil engines pass off into the atmosphere at a temperature usually of 800 to 1000° F. or more. Many attempts have been made to utilize the heat in these exhaust gases for heating water or generating steam, but difficulty has frequently been experienced with the corrosion of such heaters, due to the condensation of sulphurous acid in the exhaust. Such corrosion is especially apt to cause trouble at the joints of the heater.

A remarkably compact and well designed heater for utilizing the exhaust from gas engines has recently been invented by Mr. John L. Bogert, Consulting Engineer of the New York Engine Co., of Watertown, N. Y. Mr. Bogert's heater is illustrated in the accompanying drawings. As there shown, the heater is made up of a number of hollow rings of cast iron, which are joined together by threaded nipples at the centers. The outside surface of each ring or section is covered with projecting ribs to increase the surface exposed to the hot gases.

After the several sections are joined together, the heater is placed in a cylindrical steel casing which may be lined with brick or other nonconducting materials. The hot jacket water from the gas engine is piped to the heater as shown in Fig. 1, which illustrates one of these heaters which is in operation in the boiler shop of the New York Engine Co. at Watertown, N. Y. The gas engine which drives this shop is a duplex machine with cylinders 15x21 in. The heater to which the exhaust gas is piped has a shell 26½ in. in external diameter and is made up of fourteen sections, making the total height of the heater about 6 ft. The total surface exposed to the hot gases on each section of the heater is about 11 sq.ft.

In this installation the hot water from the engine jackets and the exhaust heater is used directly for shop heating and leaves the exhaust heater at a temperature of about 200°. It is perfectly practicable, however, to use the same heater for raising steam, supplying it with hot water from the jackets. If we assume that 20% of the total heat which is contained in the gas or oil used in an internal-combustion engine is convertible into power, and that 30% more is consumed in radiation and in waste heat passing off with the exhaust gases after leaving the heater, we have 50% of the fuel used by the engine available for heating purposes by means of this combination of the engine jackets and exhaust heater.

Tests have been made of the cast-iron sections under hydraulic pressure to determine their bursting strength, and an internal stress of 1200 lb. per sq.in. was sustained before bursting occurred. The threaded nipples by which the sections are connected are coated with a mixture of zinc-white, oil and graphite before joining, so that they can be separated at any time if desired to clean scale from the interior. The manufacture of the heater involves nothing but the casting of the section in the foundry, the internal threading and the screwing together by the nipples.

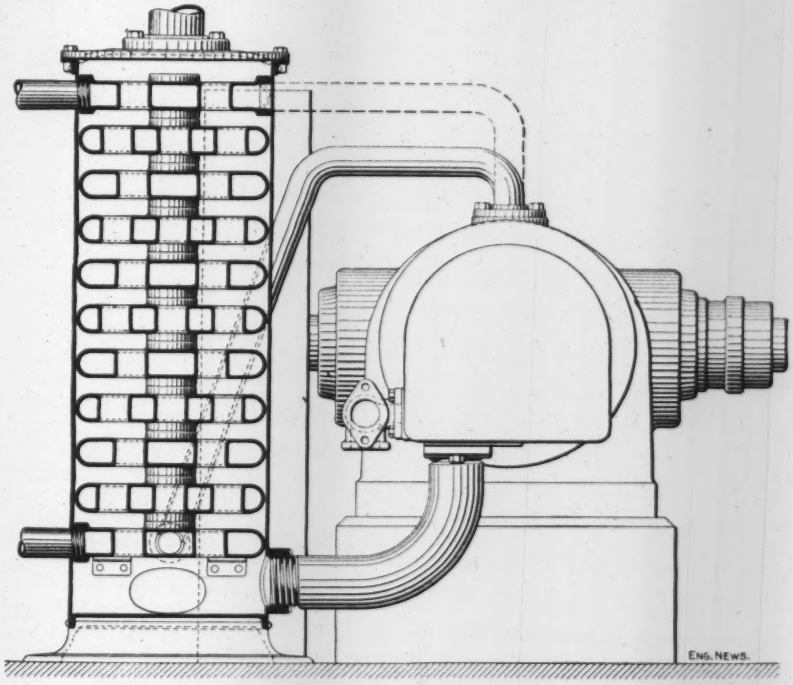


FIG. 1. SECTION OF CAST-IRON BOILER FOR UTILIZING HEAT FROM GAS ENGINE EXHAUST

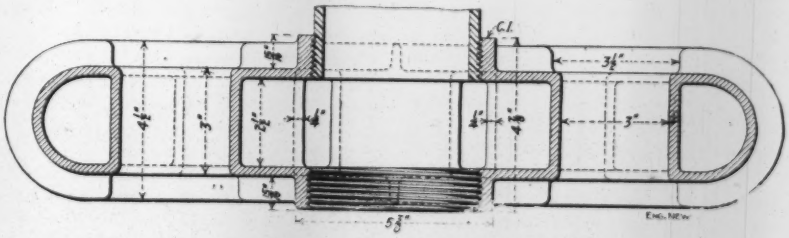


FIG. 2. DETAIL CONSTRUCTION OF ONE SECTION OF BOILER FOR GAS ENGINE EXHAUST

In the summer when there is no demand for the hot water from the exhaust boiler it may be run dry and is as efficient a muffler for the exhaust then as when in use as a heater.

At times when the gas engine is not running, the heater may be kept in operation by placing a small furnace below it and passing the hot gases from the furnace through the heater. In this way a building which is warmed during the day by the exhaust heat from the gas engine can be kept warm at night.

## The Compensation Acts of Foreign Countries*

Within the last few years, the various states, as well as the Federal government, have been enacting laws along the lines of the compensation acts of the various foreign countries, or have had commissions at work. These latter laws have superseded the common law of employers' liability, which is still on the statute books of many of the states.

Under the Employers' Liability Acts, the injured workman sued his employer for damages under the common law, and in a majority of cases, the amount of damages he recovered through the court has been eaten up by the lawyer's fees, so that he has received only about 20% to 30% of the amount awarded. Besides there has been the delay incident to the award, so that quite often it has been a year or more before he has received his money, whereas the time he most needed his money was the time of the accident or immediately afterward. In the Workmen's Compensation Acts, the injured workman receives a definite amount at the time of the accident.

There is in many minds a confusion between the common-law doctrine of employers' liability and the Workmen's Compensation Acts. Under the common law, the employee has the right of action against the employer in cases where injury from accident results as a consequence of the negligence of the employer or of someone charged with the performance of his non-delegable duties; but if the injured employee contributed by his own negligence to cause the accident, such contributory negligence bars recovery. Ordinary risks incidental to the employment are held to be assumed by the employee, and for injuries resulting therefrom no recovery of damages can be had.

The idea of compensation is that of the award of a fixed sum for injuries for which the employment is responsible, without the necessity of litigation or the endeavor to determine the question of fault. It is frequently provided, however, that where an employer is apparently grossly negligent, damages will be recoverable in addition; and if the employee is willfully or grossly negligent he shall get nothing by way of compensation, or otherwise.

With this distinction in mind between what is known as compensation laws and employers' liability, it will be of interest to know that the first compensation act became a law in Germany 25 years ago. The law was enacted July 6, 1884, and it went into effect Oct. 1, 1885. Since that time nearly every country in Europe, with the exception of Switzerland, has enacted compensation laws, thereby taking from the statute books the old common-law doctrine of employers' liability, which experience has shown to involve uncertainty, delay and expense. The following list shows the countries and the time the first compensation laws were enacted, also the time they went into effect:

| | Date of Enactment | Date law went into effect |
|---|---|---|
| Austria | Dec. 28, 1887 | Nov. 1,1889 |
| Belgium | Dec. 24, 1903 | July 1, 1905 |
| Denmark | Jan. 7, 1898 | Jan. 15, 1899 |
| Finland | Dec. 5, 1895 | Jan. 1, 1898 |
| France | Apr. 9, 1898 | July 1, 1899 |
| Germany | July 6, 1884 | Oct. 1, 1885 |
| Gt. Britain | Dec. 21, 1906 | July 1, 1907 |
| Hungary | Apr. 9, 1907 | July 1, 1907 |
| Italy | Mar. 17, 1898 | Sept. 17, 1898 |
| Netherlands | Jan. 2, 1901 | June 1, 1901 |
| Norway | July 23, 1894 | July 1, 1895 |
| Russia | June 15, 1903 | Jan. 14, 1904 |
| Spain | Jan. 30, 1900 | July 28, 1900 |
| Sweden | July 5, 1901 | Jan. 1, 1903 |

Besides these countries, the following states have compensation laws: Alberta, British Columbia, Cape of Good Hope, Greece (law applies only to mining), Luxemburg, New South Wales (law applies only to mining), New Zealand, Quebec, Queensland, South Australia, Transvaal, West Australia.

In Belgium and Great Britain, the laws apply to practically all employment. In France, Great Britain, the British Colonies and Hungary, the laws apply to salaried employees and workmen equally. In Australia, Belgium, Denmark, Finland, Germany, Italy, Luxemburg, Netherlands, Norway, Russia, Spain and Sweden, they apply only to wage earners and, in some cases, to overseers and technical experts. Overseers and technical experts, earning more than a prescribed amount, are excluded in Belgium, Denmark, Germany, Great Britain, Italy, Luxemburg and Russia. Employees of the state, provincial and local officials usually come within the provisions of the acts.

The entire burden rests upon the employer in all but six countries—Austria, Germany, Greece, Hungary, Luxemburg and New South Wales, where the employees bear part of the expense.

The laws, in every case, fix the compensation to be paid and, with but one or two unimportant exceptions, the compensation is based upon the wages received by the injured person. It consists of allowances for temporary disability and annual pensions or lump-sum payments for permanent disability or death, to which are frequently added the expenses of medical and surgical treatment and a funeral benefit.

The European countries have found the compensation act of little use unless obligatory insurance guarantees the compensation awards to the injured workmen without overburdening the small employer. Therefore, there are found many forms of insurance plans in the various countries. Without going too deeply into the various plans, they can be divided into two large classes, compulsory and voluntary. Again, each can be divided into two sub-classes, compulsory insurance in prescribed institutions, and compulsory insurance with choice of insurance institutions. Under voluntary insurance there are private companies or mutual associations, with state institutions competing, and private companies or associations without state institutions competing.

Among the countries having compulsory insurance are Norway, Hungary, Austria, Germany, Italy and Netherlands. Those having voluntary insurance are Sweden, France, Belgium, Denmark, Great Britain and her colonies, Russia and Spain.

*From the Journal of Industrial Safety for November, 1911.

## The Siphon Crew*

By Berton Braley

Up at the Storm King Cañon they're working us day and night;
We've got our standard to hold to, we've got contractors to fight;
We live in boots and a slicker, we sleep when we get the time,
And our faces and hands are plastered with stickiest hard-rock grime;
We're too dog-tired for drinking, too sleepy to touch a card;
Our talk is all of the siphon—of rock that is soft or hard.
The wise guys laughed at the project; they said it would "never do"!—
But up at the Storm King Cañon we're putting the siphon through!

We sunk a shaft in the mountain, where only the goats had played—
Where you had to hang by an eyelash to handle a pick or spade.
A shaft went down by the river—and the water commenced to pour;
And we plotted a plan to plug it—for that's what our pay is for.
We diamond-drilled on the bias, we sunk a shaft in the silt,
And sometimes the cold would numb us and often the heat would wilt.
We sought bedrock for ages and finally got a clew—
And down at the 'leven hundred we're putting the siphon through!

A seam was struck in the heading, far under the river-bed;
The water filled up the working and all of the runners fled.
But the pumps were set to going—we made a bulkhead to block;
And now once more the drillheads are battering at the rock.
The "hard-rock" gang were peaches—they entered into the game,
They laughed at the thought of danger, they took each chance as it came;
And, though there were politicians who tried to hand us a few—
Up at the Storm King Cañon we're putting the siphon through!

It's tough—but it sure is worth it; it's rough—but it's bully fun
To do the thing that the wise guys have prophesied can't be done;
And when the job is over and the water is rushing in,
Why—then is our chance to chuckle and then is our hunch to grin!
The stream will come from the mountains and into the thirsty town,
And we will have done our portion of bringing the water down;
So what if the work is wearing and things will go askew—
Up at the Storm King Cañon we're putting the siphon through!

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# Water Supply for Dallas, Texas

By Eugene Couch*

**A million dollar additional water supply has recently been completed for a Texas city with a population of 92,104. The new reservoir is on White Rock Creek and has a storage of seven billion gallons.**

*Office Engineer, City Engineer's Office, Dallas, Tex.

In April, 1908, the citizens of Dallas voted on bonds for the sum of $1,000,000 for an additional water-supply made necessary by a rapidly increasing population. In 1900 the population was 42,000 and in 1910, 92,104. During the past year the city experienced a water famine† which gave all too convincing proof of the necessity for this new reservoir, which is now completed.

The new supply comes from White Rock Creek, about five miles northeast of the city. White Rock Creek is located between the Elm Fork and what is known as the East Fork of the Trinity River. The creek rises about 30 miles northeast from the city of Dallas and flows in a southerly direction into the Trinity River about five miles south of the city. The watershed comprises an area of 114 sq. mi., about 40% of which is in valley farms and 60% rolling hilly land. The population of the watershed is very scattering for this part of the country, there being only two small villages which drain into the reservoir. The average fall of the stream per mile for the lower 4 miles is 9 ft.; for the remaining distance to the source the fall per mile is 15 ft.

Preliminary surveys and estimates were made in 1908 and 1909 under the direction of Mr. J. M. Preston, City Engineer. The city purchased about 2214 acres of land at an average price of $79.68 per acre. About 1600 acres will be under water when the reservoir is full. Plans and specifications were prepared by the writer under the direction of Mr. Preston and Mr. J. M. Basset, Chief Engineer of the city water-works. Messrs. W. B. Parsons, M. Am. Soc. C. E., of New York City, and J. B. Hawley, M. Am. Soc. C. E., of Fort Worth, Tex., were retained as consulting engineers.

†Eng. News, Aug. 10, 1911, p. 169.

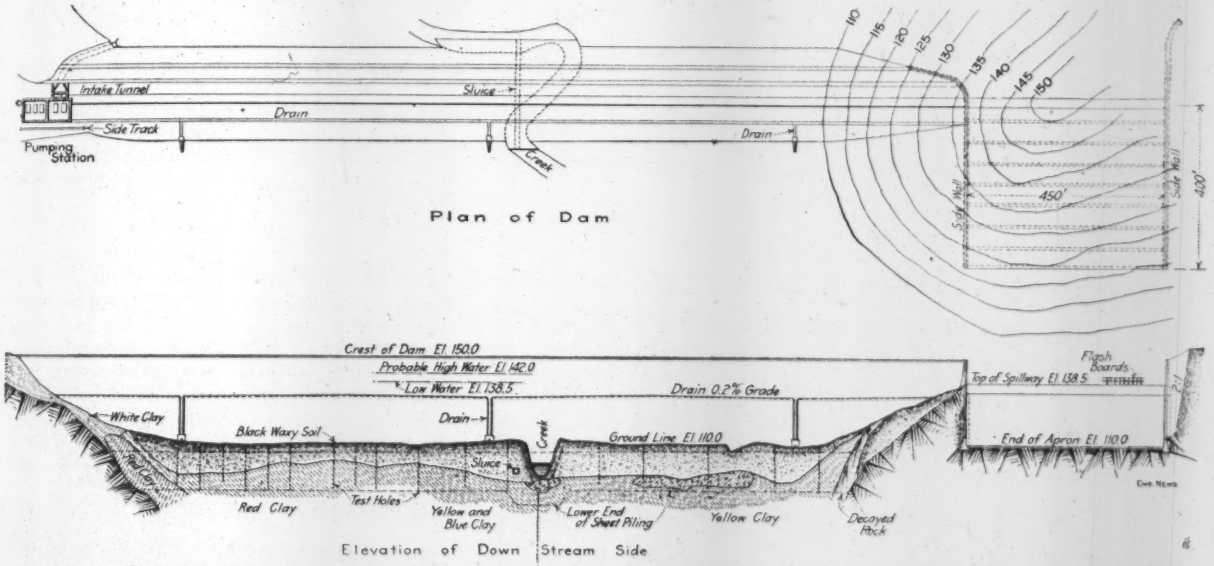


FIG. 1. PLAN, PROFILE AND CROSS-SECTION OF THE WHITE ROCK CREEK DAM; DALLAS, TEXAS, ADDITIONAL WATER SUPPLY

SLUICEWAY—Prior to the construction of the dam a concrete sluiceway 4x6-ft. in section was constructed to take care of the water of the creek. This sluice was fitted with a wooden gate at its upstream end and enough water was retained in the creek bed for use during construction. After the completion of the dam the sluice was plugged with 10 ft. of concrete placed near the gate, and clay was tamped in to a point underneath the first and second berme and at the center of the dam.

Considerable trouble was experienced in making the plug watertight as the sluice had developed cracks extending from about 6 in. above the floor on one side to a corresponding point on the other side. The floor did not show any cracks. The cracks in the sides and roof were from 8 to 10 ft. apart, and varied from a mere hair crack near the bottom of the sides to some ¼-in. wide in the roof. The water found its way along outside and past the baffle walls and into the sluice. A 1-in. pipe was carried through the plug as the work progressed to a point about 30 ft. below the center of the dam. Here a place free of cracks was found and three coats of "Hydrocide" were applied to the inside of the sluice, and a 5-ft. plug of mortar composed of 1 part cement and 3 parts sand with 10% "Non-ab" waterproofing was placed by pumping under pressure of about 20 lb. per sq.in. The 1-in. pipe was extended through the plug and allowed to remain open for six days, after which the valve was closed, and as no water appeared for three days it was decided to finish the plugging. Clay was tamped in to a point about 25 ft. from the downstream end of the sluice, where another 5-ft. section of plain concrete was put in. Then 15 ft. of clay and finally another 5-ft. section of concrete were added. At present there is about a 25-ft. head of water on the sluice with no sign of seepage.

EMBANKMENT — The earth embankment forming the main part of the dam is shown in plan, elevation and cross-section in Fig. 1. Along the center line of the trench excavated for the clay puddle, sheet piling composed of three thicknesses of 3x12-in. yellow pine timbers was driven. Near the creek bed this piling was driven 26 ft. deep. The sheet piling on the spillway end was

stopped 240 ft. from the spillway wall, and an 18-in. concrete core-wall constructed extending about 2 ft. into the solid rock on which the spillway is built. On the pumping station side the sheet piling was stopped about 114 ft. from the pumping station wall and an 18-in. concrete core-wall built the remaining distance.

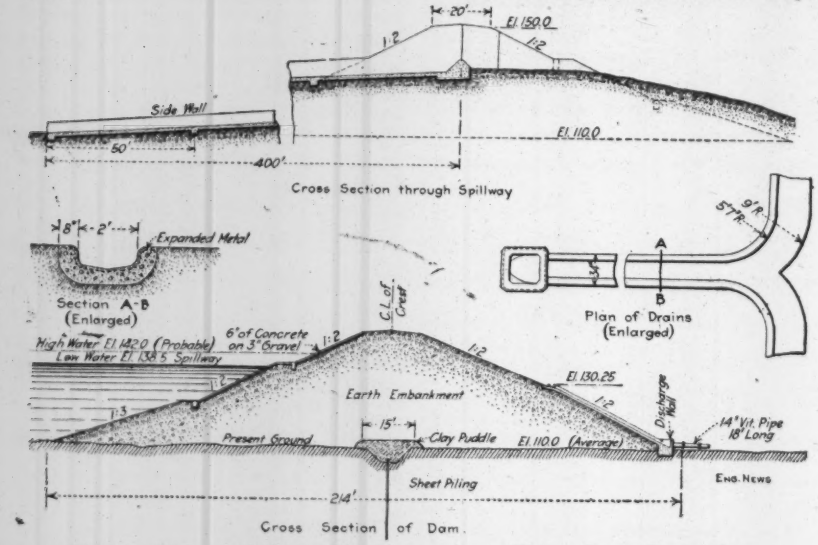


FIG. 2. CROSS-SECTION OF SPILLWAY OF THE WHITE ROCK CREEK DAM

Before starting the fill all top soil on the dam site was removed to a depth of 18 in. except at the creek bed where all soil was removed down to clay. The area of the dam was roughened by plowing it into furrows lengthwise of the dam about 6 in. deep and about 30 in. apart. The embankment was constructed of selected earth and clay placed in layers of about 12 in. in thickness, free from hard lumps, and sprinkled and rolled with a corrugated roller weighing about two tons. This roller was found to be unsatisfactory, and a 15-ton roller was substituted. The placing of the material in the dam was accomplished by two balanced cableways one with a 4-cu.yd. bucket and one with a 3-cu.yd. bucket. By this means the material was placed to Elev. 140, after which the cable ways were removed and the remaining portion of the embankment was placed by wagons. Elevating graders being used to load the wagons, all material being taken from above the dam.

PAVING—The upstream slope of the embankment as shown in Fig. 1 is paved with 6-in. concrete slabs reinforced with 1½-in. diamond mesh expanded metal. The slabs are placed on 3 in. of tamped gravel, and are 8 ft. by 10 ft., cast in place with joints broken. This paving was started at the berme Elev. 125 and continued to Elev. 150.

SPILLWAY—The spillway was constructed substantially as shown in Fig. 2 with the exception that 100 ft. of the floor was omitted on the downstream end, it being considered unnecessary to use the concrete floor on a solid rock foundation. The side walls, however, were carried about 3 ft. into solid rock, and extend 400 ft. below the center line of the dam. The floor was constructed of concrete composed of 1 part cement, 2 parts sand, and 4 parts gravel, laid in 50-ft. sections reinforced with 3-in. mesh, No. 10 gage, expanded metal placed 2 in. from the top of slab.

Expansion joints 6 in. deep made of two thicknesses of heavy building paper were constructed entirely across the spillway at distances of 50 ft. center to center, and over each cross wall. Longitudinal joints were made in the same manner. The 50×50-ft. floor slabs were placed so as to break joints.

The spillway is equipped with 24-in. flash boards for storing 2 ft. additional water.

INTAKE TUNNEL—The water enters the pumping station through a 6×8-ft. reinforced-concrete tunnel. An open cut 15 ft. wide was originally planned, but after making borings and starting the work the amount of rock encountered seemed so much greater than contemplated that it was decided to make a straight cut into the hill 9 ft. wide, and to construct a concrete tunnel. This cut was back filled with selected material well sprinkled and rolled. A saving of about $7,500 was made over the cost of the open cut.

PUMIPNG STATION—The pumping station is located at the northwest end of the dam, and is 50×134 ft. in plan and 45 ft. high. The boiler room is equipped with three 300-hp. return tubular boilers with feed-water heater, feed pumps, fire pump, auxiliary engine and dynamo. The engine-room is 67 ft. by 50 ft., with room for two pumping engines of 20 million gal. daily capacity.

A cross-section of the pumping station and intake wells is shown in Fig. 4. The building is well equipped with storeroom, tool-room, bath-room and engineer's office. The engine-room is equipped with a 12-ton hand-power traveling crane. The boiler plant has a 140-ft. reinforced concrete chimney. A spur track from the Missouri, Kansas & Texas Ry., 2½ miles in length, greatly facilitates the delivery of construction material and will be used for the delivery of coal when the station is complete.

The water is taken directly into the city distribution system by a 36-in. main, connecting with two city mains at the corner of Live Oak and Fitzhugh Sts. Near Sta. 78 on the pipe line is a steel standpipe 20 ft. in diameter and 70 ft. high, connected to the pipe line by a 16-in. pipe. This is intended to serve as surge tank.

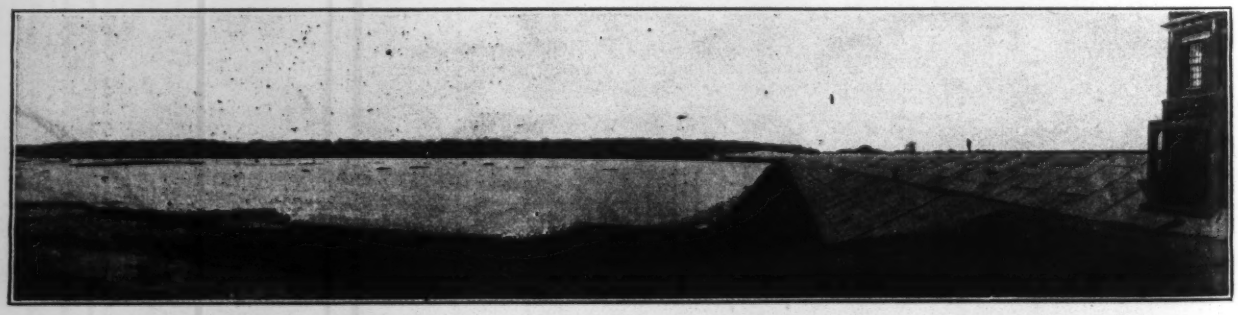

FIG. 3. GENERAL VIEW OF THE WHITE ROCK CREEK DAM AND RESERVOIR OF DALLAS, TEXAS

The accompanying tables give the itemized cost of the entire project:

| | |
|---|---|
| **ENGINEERING AND LEGAL SERVICE** | |
| Special attorneys for purchase of land | $5,000.00 |
| Consulting engineers | 6,000.00 |
| City engineer, 3 months at $200 (est.) | 600.00 |
| Plans and specifications, 1 mo. (est.) | 125.00 |
| Printing specifications | 34.00 |
| One engineer, 18 mo., at $125 | 2,250.00 |
| One levelman, 18 mo., at $75 | 1,350.00 |
| One concrete inspector, 18 mo. at $75 | 1,350.00 |
| Two rodmen, 18 mo., at $100 | 1,800.00 |
| Preliminary surveys (est.) | 750.00 |
| **LAND** | |
| 2,213.64 acres | $176,420.92 |
| **VARIOUS CONTRACTS** | |
| Clearing reservoir site | $16,067.16 |
| Fencing | 428.00 |
| Roads, changing location, etc. | 8,208.86 |
| Pipe line | 130,230.64 |
| Standpipe complete | 5,746.80 |
| Pumping station | 32,258.63 |
| Traveling crane | 1,125.00 |
| Concrete chimney | 2,200.00 |
| Pump foundation | 1,224.64 |
| Twenty million-gallon pump | 75,000.00 |
| Boilers and fixtures | 8,750.00 |
| Grubbing, 9.75 acres, at $35 | 341.25 |
| Removing material from bed of creek, 1651.06 cu.yd., at 70c. | 1,155.74 |
| Removing objectionable top soil, 12,773.2 cu.yd., at 18c. | 2,299.18 |
| Excavation of puddle trench, 3733.30 cu.yd., at 20c. | 746.66 |
| Furnishing and driving sheet piling, 284,192 ft. B. M., at $48 | 13,641.22 |
| Earth excavation in pump station walls and intake well, 659.39 cu.yd., at 60c. | 395.63 |
| Rock excavation in pump station walls and intake well, 1318.10 cu.yd., at $1.75 | 2,306.68 |
| Concrete in pump station and intake well walls, 1353.75 cu.yd., at $9.95 | 13,469.81 |
| Earth excavation in intake tunnel, 2402.04 cu.yd., at 30c. | 720.61 |
| Rock excavation in intake tunnel, 1143.91 cu.yd., at $1.50 | 1,715.87 |
| Concrete in intake tunnel, 432.90 cu.yd. at $9.30 | 4,025.97 |
| Backfill over intake tunnel, 1776.24 cu.yd., at 16c. | 284.20 |
| Placing clay puddles, 6963.06 cu.yd., at 65c. | 4,525.99 |
| Concrete walk over spillway, 450 lin.ft., at $3.60 | 1,620.00 |
| Concrete in retaining walls for upstream face paving, 955.36 cu.yd., at $6.60 | 6,305.38 |
| Earth excavation in spillway, 30,872.45 cu.yd., at 21c. | 6,483.21 |
| Rock excavation in spillway, 29,209.18 cu.yd., at $1.05 | 30,669.64 |
| Concrete in sidewalls of spillway, 940.05 cu.yd., at $9.95 | 9,353.50 |
| Concrete in floor and cross-walls of spillway, 4585.54 cu.yd., at $7.50 | 34,391.55 |
| Concrete in dam of spillway, 855.69 cu.yd., at $7.60 | 6,503.24 |
| Earth excavation in sluiceway, 946.29 cu.yd., at 80c. | 757.03 |
| Construction of sluiceway complete, 335 lin.ft., at $9.50 | 3,182.50 |
| Filling sluice with concrete, 48.5 lin.ft., at $9.75 | 472.88 |
| Filling sluice with clay puddle, 286.5 lin.ft., at $1.75 | 501.38 |
| Placing material in embankment, 333,680.78 cu.yd., at 34½c. | 115,119.87 |
| Paving upstream slope of dam, 13,636.96 sq.yd., at $1.45 | 19,773.59 |
| Construction of drains on downstream slope, 1956.5 lin.ft., at $1.33 | 2,641.28 |
| Construction of discharge wells, 3 wells at $65 | 195.00 |
| Sodding downstream side of embankment, 19,064.6 sq.yd. at 8c. | 1,525.17 |
| Total | $285,124.03 |

The following extra work was performed:

| | |
|---|---|
| Rock exc. W. Side pump sta., 248.76 cu.yd., at $1.25 | $310.95 |
| Earth exc. W. Side pump sta., 247.83 cu.yd., at 25c. | 61.96 |
| Earth exc. in pump sta., 718.2 cu.yd., at 25c. | 179.55 |
| Rock exc. in pump sta., 663.4 cu.yd., at $1.25 | 829.25 |
| Round piling in place under sluice, 800 lin.ft., at 33c. | 264.00 |
| Rock exc. in core walls, 72.95 cu.yd., at $1.75 | 127.66 |
| Earth exc. in core walls, 123.33 cu.yd., at 60c. | 74.00 |
| Concrete without reinforcing in core walls, 203.66 cu.yd., at $8 | 1,629.28 |
| Extra labor and material in placing "Non-ab" concrete blocks in sluiceway | 291.27 |
| Total | $3,767.92 |
| Grand total all improvements | $765,811.60 |

The general contract for the dam, spillway, and pumping station foundation was awarded to the Fred A. Jones Construction Co., of Dallas, Tex. Active work was begun March 28, 1910, and completed Sept. 11, 1911. Work was carried on under the direct supervision of Mr. J. E. Lewis, General Superintendent for the contractor. Mr. John M. Young, Principal Assistant City Engineer, was Engineer in charge of construction.

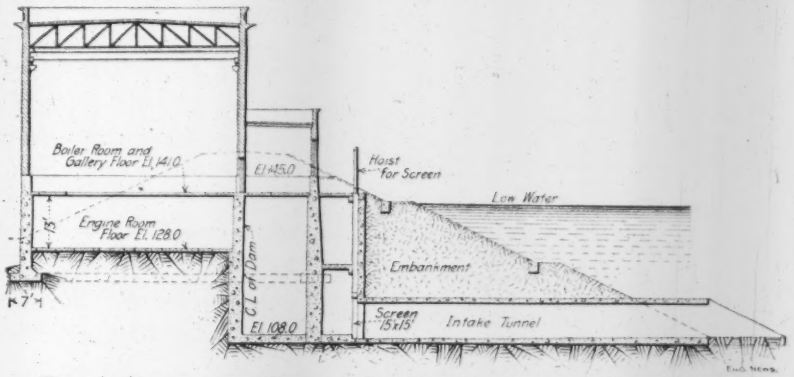


FIG. 4. CROSS-SECTION THROUGH PUMPING STATION AND INTAKE WELLS; WHITE ROCK CREEK RESERVOIR

The writer would consider this article incomplete without mentioning the Hon. S. J. Hay, Mayor, Commissioners D. F. Sullivan, W. M. Doran, and City Engineer J. M. Preston, who in the face of severe criticism have projected and carried through according to the advice of Messrs. Parsons and Hawley, a project that a city several times the size of Dallas could justly be proud of.

There is at present about two hundred million gallons available above the bottom of the intake tunnel. The estimated available capacity to Elev. 138.5 is six billion gallons; with 2-ft. flash boards seven billion gallons. At present the average daily consumption is eight million gallons, no sprinkling being required. With sprinkling the consumption runs as high as fifteen million gallons. The present Board of Commissioners have ordered meters installed, and within the next year it is intended to have the entire city metered.

**Tests of Waterproofing Compounds** are to be undertaken by the Chicago Subway Commission. Manufacturers of such compounds are invited to communicate with the commission (Borland Block, 105 South La Salle St., Chicago, Ill.), with a view to having their product included in these tests.

**Public Comfort Stations** have been established in a dozen American cities since 1895, according to a special report on this subject by Frederick L. Ford, until recently city engineer of Hartford, Conn. (This report forms the major portion of the fourth annual report of the Commission on the City Plan, Hartford, Conn., for the year 1910-11.) The first two stations were built in Washington, D. C., in accordance with an act of Congress passed in 1905. The cities having these stations are as follows, each city having one unless otherwise stated by numbers placed in parenthesis: Atlantic City, N. J.; Baltimore, Md.; Boston, Mass.; Cincinnati, O.; Denver, Colo.; Detroit, Mich.; Lawrence, Mass.; New York City (8 in Manhattan and 6 in Brooklyn Borough); Washington, D. C. (2), and Worcester, Mass. The number of patrons at the six Brooklyn stations, in what Mr. Ford calls an average year, ran up to the surprisingly large number of 12,125,317, of whom all but 12% were males. The importance of proper heating and ventilation is given considerable attention in the report. The constructional cost of a well-equipped public comfort station is given in the report as ranging from $10,000 to $20,000. The cost of the New York stations has averaged less than $25,000 each for those in Manhattan Borough, and about $20,000 each for those in Brooklyn. The station at Lawrence, Mass., cost $13,200, and was erected in 1907. Operating costs, naturally enough, depend largely upon such local conditions as number of patrons, character of attendants, the number of hours the stations are kept open. For one of the underground stations in Brooklyn, N. Y., with an average daily patronage of about 5100 men and women, the men's department being open 24 hours a day and the women's 16 hours a day, the total yearly operating cost was $6751, or about one-third of a cent for each patron. At some stations the labor item alone ranges from 65 to 90 per cent. of the total annual operating expense. Some public comfort stations in England and Scotland are self-supporting. A few of the American stations derive some income for the use of pay closets, soap and towels. The report as a whole contains a large amount of detailed information regarding public comfort stations, both in this country and abroad, and should be useful to any city engineer or other officer charged with the duty of designing such stations, or operating them after they were built and in use.

# Dust in Portland Cement Plants

By Otto Schott†

**The elimination of the dust generated in the manufacture of cement is one of the problems of the industry. In this paper the author describes the many devices now in service in European mills to reduce the nuisance.**

*Paper presented, under the title, "The Dust Problem in Portland Cement Plants and its Solution," at the annual convention of the American Society of Mechanical Engineers, New York City, Dec. 5-8, 1911.

†Consulting engineer, Fifth Ave. Bldg., New York City.

There are few branches of industry that can vie with that of portland cement manufacture in the production of dust. Cement factories working with the wet or half-wet process are an exception to this, since dust from drying and grinding the raw materials and in burning the clinkers is not encountered. There are many sources of dust with the wet process in common with the dry, such as the drying and grinding of the coal, the grinding of the clinkers and the packing of the cement. In any case, the dust-eliminating question presents itself as an urgent problem. The dust collector has become a necessity for any cement plant. But little experience having been so far gathered in America in this particular respect, the explanations in this paper will be based on the experiments and experiences of German cement factories, in which such devices have been in operation for a long time.

The dust-eliminating devices used in European cement factories have, generally speaking, hygienic motives, inasmuch as the authorities demand the use of such contrivances that will protect the physical welfare of the workmen and keep the environs of the factory free from dust. The great progress made in this line, however, would hardly have been possible for this reason alone, had not the dust-collecting devices been found to represent the means of great economy and money-making.

Two points to be considered are: (*a*) Dust-eliminating contrivances for depositing or beating down the dust originated in grinding, packing and conveying the materials when the temperature of the dust-filled air is normal; (*b*) Removal of the dust from the waste gases of the drying drums and kilns, a more difficult problem owing to the high temperature and to the aqueous vapors contained in the gases.

## Dust-eliminating Devices

With the dust-eliminating devices first referred to it is essential that the mills and conveying contrivances causing the dust be covered or jacketed as tightly as possible. It is furthermore of great importance to withdraw the dust immediately at the place of origin, hence to connect the mills and other contrivances directly with the exhauster destined to remove the dust-saturated air by suction instead of allowing the dust first to penetrate to the outside and then attempting to cleanse the space saturated with the dust.

Every dust-eliminating plant consists in general of these principal parts, viz., the exhauster, the dust separator and the pipe conduits. Absolutely indispensable for every such plant is the exhauster which serves to remove by suction the dust-saturated air from the dust sources and to conduct the same to the dust separator; therefore the construction of this machine requires particular discrimination and care. Its volumetrical and mechanical efficiency and capacity must be as high as feasible, i. e., must be so constructed as to remove suctorially a quantity of air with the least possible consumption of power. The proper shape of the air wings and of the casings are in this device of the greatest consequence. The casings have to be so constructed as to permit the air to leave without any resistance, i. e., without any concussions or shocks.

The width of the suction aperture of the exhauster is dependent on the requisite working result relative to the air, multiplied by the degree of depression. Greater air actuating work and smaller depression necessitate a wide suction aperture and vice versa. Considering the great number of revolutions in the exhausters, reversible ring lubricated bearings are the most advantageous.

For cleansing the dust-saturated air drawn through the exhauster by suction there are three technical methods in use: (*a*) diminution of the velocity of the air; (*b*) filtration of the air through jute filters and (*c*) elimination by centrifugal force.

## Diminution of Air Velocity

With the first method mentioned of removing the dust, the dust-saturated air is led into large chambers and thereby undergoes a diminution of speed proportionate to the cross-section of the chamber. Consequently a large portion of the dust is deposited on the bottom of the chamber. In order to produce satisfactory results, such chambers must have relatively considerable dimensions. It is not difficult to free small mills from dust by this contrivance, but for larger plants the requisite dimensions must increase according to the third power of the size of the plant. In Europe, where the cement industry dates rather far back and where the rotary kilns were taken from America, the spaces enclosed by the now disused ring kilns are suitably utilized as dust chambers, being sufficiently spacious for that purpose. Moreover, the construction of such dust chambers is not expensive, provided the requisite space is available. They may be built from cement or gypsum boards 2 in. thick, as in many factories in Germany. The dust falling to the bottom of the chamber is removed automatically by a screw, spiral or chain conveyor. The separation of dust may also be increased by constructing baffle works in the chamber which causes contact or friction with the air. Sometimes we find objects of resistance in the shape of wire-netting stands or hemp skeins suspended in the chambers, such devices causing the dust first to adhere to them and then drop to the bottom of the chamber. The greater portion of the dust may be deposited by the aid of such dust chambers, but a certain amount of dust will always be taken along with the air escaping from the chambers.

Dust Filters—In a consideration of the dust filter, the device most used for the separation or elimination of dust, two principles are involved: (*a*) the exhauster is inserted between the source of dust and the filters so as to cause the dust-saturated air to be pressed into the filter; or (*b*) the exhauster is arranged behind the filter and draws the dust-saturated air from the mill through the filter. The latter construction has found great favor in Germany as made by the firm of Betts, at Luebeck.

This dust collector consists of a number of separate sections of hose through which the dust-charged air is drawn by suctions. The dust adheres to the interior surface of the hose while the cleansed air is allowed to escape to the outside. In order to remove the dust from the apparatus the different hose are knocked out alternately and in shifts at regular intervals of time, by means of an ingenious mechanism. The suctorial action of the exhausters is suspended temporarily for these hose or sleeves by the automatic reversion of a flap or valve provided in the suction trunk. At the same instant the sleeves

are freed from the dust by repeated raising and sudden dropping. Besides this the atmospheric air flowing in under high pressure and entering the interior from the outside through the casings of the sleeve cleanses the latter completely. While part of the sleeves are thus being cleansed the exhauster draws the dust-saturated air by suction through the rest of the sleeve sets. Thus no interruption takes place and the dropping dust is carried away by a screw conveyor. To give an idea of the extensive application of these dust-eliminating plants, it may be stated that 20,000 sleeves with 1,600,000 sq.ft. of surface were in operation.

Of numerous factories that construct similar devices reference will be made only to the firm of Simon, Baumann and Buehler. The author saw last spring a plant furnished by them in the Portland cement works of Dyckerhoff and was astonished at the absolute freedom from dust of the milling plants of that large factory. This firm also constructs apparatus in which the sleeves are cleansed by a frame continually moving up and down on the outside of the sleeves, whereby the dust is shaken off.

This device differs in principle from the dust filters in that the dust-saturated air is not drawn by suction through the filters, but is pressed in. The dust-charged air first proceeds into the exhauster and thence into the interior of the filters, while the cleansed air leaves the filters and escapes directly to the outer air. The simplest arrangement of this order consists of a series of long sleeves suspended one beside another, perferably underneath the roof. They are about 30 ft. to 36 ft. in length and 3 ft. in diameter. The dust-charged air is introduced from above, the dust being deposited at the side and drops into bags provided underneath. Each filter sleeve is connected with the common tube conduit through a tube flange and by means of a slide may be disconnected. The sleeves are either knocked out with a bamboo cane once a day from the outside or they are cleansed automatically by a frame sliding up and down. This method of dust elimination is used with the greatest possible success and has besides the advantage of great simplicity. In the cement factory at Offenbach, Germany, still better results are produced by the dust-charged air entering through the first sleeve and passing all of the sleeves consecutively zig-zag fashion from the top to the bottom of the device.

A gigantic plant of this order has recently been constructed by a prominent cement factory in Germany. In a special structure made of corrugated sheet metal and having a height of 45 ft. are suspended no less than 144 sleeves, and in order to obtain more surface calculated on the same space, the sleeves were given a diameter of only 10 in. From each of these filters every day a sack of cement is separated. In the morning and in the evening the filled sacks are taken off and replaced by empty ones. After some preliminary experimenting, the plant now is working to perfection. Owing to the absence of any machinery in this arrangement, there are no repair expenses whatsoever.

On the same principle is based the so-called "Perfection" apparatus made by Rau and Prinz of Milwaukee, but which the author has more often seen in operation in Germany than in America. The construction is as follows:

The dust-charged air, drawn suctorially from the dust sources by an exhauster, is conducted through a pipe conduit into the central drum of the apparatus, in which a great number of radially arranged conical filter tubes terminate. The dust-charged air is distributed uniformly over the whole of the filters and the cleansed air escapes directly into the outer air. The drum is revolved periodically, so that one of the numerous rows of sleeves or tubes always stops vertically above a receptacle in the ventre. vertically above a receptacle in the centre. At this moment two rubber hammers beat down upon the row of sleeves, causing the dust to fall off, whereupon it is removed automatically by a screw conveyor from the centrally arranged receptacle. The cleansing of the sleeves, however, is simultaneously effected by the exhauster connected with the receptacle drawing a powerful current of air through the filtering sleeves. The apparatus is constructed so as to allow any deficiency in its functions to be ascertained at once.

In the selection of a filtration contrivance the particular conditions prevailing in the factory installing the device are to be considered. The leading principle in all these dust filters is the advisability of providing as large a filtering surface as possible.

CENTRIFUGAL ELIMINATION—The third method of eliminating the dust is based on the utilization of centrifugal force in the shape of so-called cyclones. The dust-charged air is blown tangentially into a cylindrical sheet-metal receptacle. The coarser parts are thereby flung upon the sides and fall out below at the conically shaped point of the cyclone. The author does not hold a high opinion of the cyclones where they are to serve for the elimination of dust from milling, or packing plants. This opinion is based on observations of such a plant in an American cement factory. The finest dust is not separated, but is whirled with the air current leaving the cyclone, into the outside air.

In the author's opinion a cyclone can be considered only as a preliminary dust collector, provided it is brought in connection with filtering sleeves. Such a filtering apparatus is placed on the market by the firm of Pfeiffer Brothers in Germany, and has proved a success wherever it has been introduced.

### REMOVAL OF DUST FROM WASTE GASES

The dust-eliminating apparatus so far described is applied in the suctorial removal of air at a normal temperature in raw mills, cement mills and in the removal of dust from conveying and packing contrivances. The apparatus may also be employed for the removal of the dust from the drying drums for raw material and coal. In these cases, however, two things have to be taken into account: (*a*) The workman attending to the drying drum must keep the temperature of the escaping vapors high enough to prevent the steam therein from undergoing condensation; he has at the same time to take care that the exhaust vapors always contain sufficient steam and are not so hot as to burn or scald the filters; (*b*) The casings enclosing the filters have to be made from sheet iron so that in the case of an ignition of the filters the fire is prevented from spreading.

In the writer's experience he has witnessed two such ignitions, and to demonstrate how carefully these things should be observed, one of the cases will be related. A "Perfection" apparatus was installed for the coal mill, which had been placed out of operation from Saturday until Monday and the dust-cleansing apparatus had been put out of commission at the same time. The coal dust adhering to the yet uncleansed filters set the whole apparatus on fire by spontaneous ignition and caused a considerable conflagration. If the cleansing apparatus had been caused to make only one more revolution, so that all the filter sleeves would have been knocked out, this fire could not have originated.

Similar things may occur when the waste gases of the drying drums are conducted at too high a temperature through the filter sleeves. This may, however, be obviated by causing cold air from the free space to be drawn by suction at the same time, prior to the entrance of the hot gases into the filtering sleeves, thereby decreasing the temperature. It goes without saying that in that case the filtering surface must be so much larger according to the quantity of the cold air introduced.

The greatest surety in freeing the heated drying drum vapors from dust can be attained by a dust chamber, which, however, must be well insulated in order to obviate the condensation of the steam. These dust chambers, on

the other hand, will prove absolutely unavailable and useless, if they are too small and not properly arranged. In this particular case, the pipe conduit leading from the exhauster to the dust chamber has been laid horizontally, with the result that the pipe is filled with dust in a short time. To overcome this defect the ventilator is run at a higher speed, thus preventing the pipe from being clogged and closed with dust, but at the same time causing at least 5% of the raw material to be carried away through the flue or smoke stack. It stands to reason that the dust chamber is far too small for the extraordinarily strong air pressure; with the high velocity of the air the dust is not allowed to deposit itself in the dust chamber. An inclined position of the pipe would of course have remedied all trouble. The construction of the pipe conduits is of the greatest importance, but this part of the greatest importance, but this part of the subject cannot be enlarged upon here.

As these dust chambers, however, have to be very large, otherwise there will always be some fine dust carried along, and on the other hand, as the cyclones, which in other respects would suitably serve for heated vapors, fail to give satisfactory results, the purification of the gases from the drying drums has been variously effected and introduced in Europe by water or steam diffusion.

Dust elimination by the wet process will be applicable wherever there is sufficient water available and where the slurry can be used. Such apparatus for the freeing of the drying drums from dust has been in operation in Germany in two of the plants of the company with which the author was connected. The construction which has proved the better and more efficient consists of sheet-metal tubes bent serpentine fashion, at one side of which the dust together with the vapors enters, while at the other side they escape in a purified condition into the free air. In the interior of the sheet-metal tube referred to there are water nozzles rigidly attached, which serve to spray incessantly finely diffused water into the rising vapors. The dust deposited in the shape of slurry flows into a receptacle or reservoir provided underneath the apparatus and is carried uniformly by a pump to the mixing worms, which serve for feeding the raw meal to the kilns, being thus burned at the same time with the raw meal. The consumption of water of such a separator amounts to about 22 gals. per min. The slurry pump has a capacity of 30 gals. per min. The ventilator that draws the gases through the serpentine shaped tube needs but 4 or 5 hp. for its operation. This apparatus, which was invented by a German machine factory, works excellently, provided the water nozzles are cleansed once a week.

In France a spraying system is employed with success, which is constructed as follows: The hot waste gases enter through a narrow tube from below into a wider tube, in which ring-shaped cells are provided in order to diffuse the gases as much as possible over the cross-section of the tube, thereby preventing them from flowing merely through the tube in the centre. At various places in the interior of the tube there are water sprays which are so fitted with small apertures or perforations as to cause the water to be diffused funnel fashion in all directions. The water that has been formed can run off through a laterally disposed pipe.

In a factory on the Rhine the author saw a contrivance in which the ventilator drawing the gases away from the drum serves at the same time to diffuse the water and to separate the dust within its casing. This apparatus works to satisfaction. The wing wheel of the ventilator has scoop rings which are immersed periodically in the water and fling it with great velocity against a very fine wire netting, thereby diffusing it. The gases are thus brought into the most intimate contact with the finely diffused water and the thin-liquid slurry is separated, which is carried away laterally. The disadvantages of this apparatus however, in the author's opinion, consist in the consumption of water being excessive, while the ventilator has of necessity to be built very stoutly and requires a good deal of power.

If a cement factory is intended to be kept free of dust, it is naturally of the greatest importance that it should act as a powerful agent in this direction if the production of dust is to be reduced to a minimum. It stands to reason that any dust that is kept away or avoided requires no elimination. In connection with the drying drum a novel device was recently introduced in Germany, which almost precludes the development of dust from the very outset. The development of dust in the ordinary drying drum is caused by the material in the interior being raised to a height of from 4 to 6 ft. by rectangular iron devices and then dropped. In the improved novel construction the interior of the drum is divided into 54 cells. The material, when the drum revolves, is turned over slowly and very little dust is originated. The efficiency of the device lies in the uniform distribution of the heating gases and in the greater surface of the sides. This drum has been patented by a machine factory in Germany.

### Elimination of Dust from Rotary Kilns

The elimination of dust from rotary kilns is particularly difficult in America, because, in contradistinction to the European fashion, individual stacks of but little height are in use. On the other side a whole row of kilns is served by a brick smoke stack of about 200 to 300 ft. The author fails to see any advantage in the use of individual stacks. On the contrary, he is of the opinion that there are a number of reasons why the high brick stacks should be given decided preference.

The most simple contrivance for the elimination of the dust from the kilns is the dust chamber with automatic emptying device. In this case, however, the dust chamber is an absolute necessity, even if other contrivances for the purification of the kiln vapors from dust are employed. In the chambers sieve walls are preferably arranged to which the dust adheres. It has been attempted to purify the waste vapors through filters and for this purpose particular filtering sleeves have been produced from incombustible asbestos fiber material. This mode has, however, not proved a success. Thereupon combinations of dust chamber and certain after-cleansing apparatus have been constructed. In these combined devices the vapors proceed through a dust chamber which is fitted with rocking or shock sides and in which a great portion of the flying dust forced along is separated. In the rear of the dust chamber are provided two water-dust depositors, into which the vapors are uniformly distributed.

In order to render the deposition of dust in the dust chambers more efficacious, particular depositors for the flying ashes have been recently constructed and patented. They are placed in the cross-section of the chamber and compel the smoke vapors to undergo a continuous change of direction when passing through the chamber. These depositors consist of pocket-like pieces of sheet metal which are disposed within the dust chamber.

These devices are in most cases sufficient when applied in connection with the high European smoke stacks. The very small amount of dust that is still forced along is carried away to great distances and is not observable in the vicinity of the factory.

### Utilization of Waste Gases

The waste gases of the kilns also contain, besides the dust, which can be recovered, another constituent which may be turned into money again. This is the heating value contained in the high temperature of the waste gases. In most factories of Europe and America this heat flies out of the stack without being in any way utilized.

When utilizing the waste gases for drying the raw material the heating value of the same is utilized but half and by

the strong draft that is then produced in the drying drums the flying dust of the kiln is joined by the dust developed in the drying drums, which must then be deposited by the application of one of the several methods referred to above, that is, with the very extensive dust-eliminating contrivance. It has therefore been attempted to employ at the same time the same contrivances for depositing the dust that are used for the utilization of the heat of the waste gases. The attempts to attain this purpose originated in America, where the heat of the waste gases was used for producing steam. The first plant of this kind was the steam boiler installation of the Nazareth Portland cement factory, which, however, was not successful. Better results were obtained by Professor Carpenter of Cornell University, but beyond making various trials no tangible results have been produced.

A practical shape was given to this underlying idea in Germany, where several such plants, which at the same time eliminate the dust and utilize the heat for the raising of steam, have been in successful operation for several years. The succession of the several appliances in this plant is: kiln, boiler, dust chamber, smoke stack. The dust chamber here serves for the deposition of the last dust particles. The principal quantity of dust adheres to the tubes of the tubular water boilers and then drops down to be carried away automatically. Of course with the completion of this device extended preliminary experimenting has been necessary and the proper success is solely dependent on the manner in which the boilers are walled in. The dust adhering to the tubes is removed by compressed air, a process which offers no difficulties whatever. Naturally, special precautionary measures are to be taken to avoid a cooling down of the tubes of the boiler when blowing off. The blowing off by means of steam has been an entire failure.

The author regrets that he is unable to present particulars concerning the device with which he is well acquainted, since it is an invention by a cement company which has so far applied this method only in its own works. Certain details may be given, however, in regard to the efficiency of the plant.

One of the principal advantages with this method consists in the flying dust being separated. The heaviest particles, consisting of the already burned and finest cement, drop in consequence of their own weight to the first boiler tube rows and are taken up independently, and immediately added to the cement. It has been demonstrated by examination that the cement gains considerably in quality and strength by the addition of these constituents. The lighter parts are first knocked against the rear rows of the boiler tubes or are deposited in the dust chamber. They consist of underdone cement or raw meal and are burned again. The steam generated by the boilers located behind the kilns is almost sufficient for actuating the entire rotary-kiln plant and the mills in the raw mill. In this plant the waste gases are utilized by 14 boilers, which in turn serve as dust separators. Seven of the 14 kilns communicate with a special stack 300 ft. in hight which is connected with the dust chamber located in the rear of the boilers. The boilers situated behind the kilns have themselves no auxiliary firing and are served by two laborers, who have nothing to do but replenish the evaporated water. The evaporation being dependent on the working of the kilns, a special boiler, in addition to those connected with the kilns, which is continually fired, serves to compensate the requisite quantity of steam for the machines. According as the rotary-kiln boilers supply more or less steam, the extra boiler must be fired in a greater or lesser degree. In this plant 60 bbl. of dust are collected daily, a fact which may demonstrate its economical character.

The problem of completely utilizing the waste gases of the rotary kilns and of freeing them from dust is considered solved in Germany. In the place of the ordinary draft furnished by the smoke stack a large exhauster is used for the kilns which draws the waste gases through a system of economizers, steam boilers and superheaters, where they are sufficiently cooled to be blown directly into one of the filter dust-eliminating apparatus. This installation is under construction and the author is unable to present any particulars at this time. The importance of this contrivance is significant in that, on the one hand, the smoke stack becomes completely superfluous, while the gases are entirely freed from dust and the waste heat is utilized up to the highest potency for generating steam.

## Economy of Dust Elimination

In order to demonstrate and to prove what enormous quantities of cement may be saved by the dust elmination in cement and raw mills, an example for practical experience will be given. The plants of the works referred to are fitted with Bett's sleeve filters with which daily experiments and tests were made. This factory has a daily production of 1000 bbl. In one day, i.e., in 23 hours, 3800 kg., or 166 kg. per hr., of cement was collected. As conditions are in Germany, where 100 kg. of cement cost about 75c., the daily gain is approximately $28.50. In the raw mill about 2000 kg. of meal are collected, representing a value of about $6. Hence the daily saving amounts to about $34.50, or $10,350 per year, reckoned as 300 days.

The dust-eliminating plant for this factory had involved an expenditure of $4,500. For power, the annual outlay amounted to $750, and about $250 was expended for repairs. The expense of the plant therefore was covered by the savings in about 6 months. The quantities of dust that are regained in a dry state by the application of the dust filters amount to from 2 to 4% of the entire output.

These results were produced in a Silesian factory by the aid of Bett's filters. A second instance of the practical working of a slag cement factory is one in which dust filters from the works of Simon Buehler and Baumann are in operation with the best success. In this factory which has an output of 16,500 tons, a yearly saving of 495 tons was effected in cement meal alone, by means of the filters, which, at the rate of $4.50, amounts to $2,250. This quantity of recovered material would otherwise have been lost as waste material. This instance may serve as a computation of rentability for the purpose of demonstrating how excellently such plants make themselves pay.

The gain that is open to proof is thus demonstrated in black and white. But an advantage or gain of at least the same value is involved in various other circumstances, with which a rationally applied dust-eliminating plant, offer considerable economical advantages.

Above all, it must be mentioned that the working power of the mills will be perceptibly increased if the heat produced by the disintegration of the never entirely dry limestone, cement clinker and steam is carried away.

Furthermore, by dust elimination the depositing of the dust on the machinery is avoided, whereby the wear and tear of the same is considerably reduced. It is less the raw meal than in a far higher degree the cement meal that produces wear on the rotating machine parts, in the manner of emery, more particularly when it has access to bearings which can never be so protected as to be entirely dust tight. There is not the least doubt that the superintendence and the tending of the machine plant are also materially facilitated in avoiding such disturbances.

In conclusion, it may be mentioned that the health and life of the laborers working in cement factories speak forcibly for the introduction of dust-eliminating plants, while they offer in addition the advantage of having and obtaining steady and more cheerful workers.

The author believes that he has treated the subject sufficiently to demonstrate that the dust-eliminating problem merits close attention, and that all cement fac-

tories will have to concern themselves with this problem for economical reasons. If a factory having a daily output of 1000 bbl. saves upwards of $10,000 a year by recovering the otherwise lost dust from the raw and cement mills, the great losses accruing to factories producing 5000 or 20,000 bbl. per day may be easily calculated. Furthermore, if it is considered that by means of suitable contrivances the whole of the dust and the high waste gas temperatures which now escape from the stacks of the kilns can be utilized to advantage, it cannot be regarded as an exaggeration that in the American cement industry many hundred thousand dollars are wasted and squandered every year, and that at a time when the price of cement has fallen to a level leaving hardly any margin for the manufacturer.

# The Management of Water-Works*

By Allen Hazen †

**Speaking with reference to municipally-owned water-works, the author urged the members of the association to address themselves to better administrative methods, particularly as regards accounting, rates and placing water-works on a sound financial basis. It was suggested that municipal, as well as private, works should earn a profit on the total investment, even after bonds are retired.**

*A portion of the retiring address of the President of the New England Water Works Association, delivered in Boston, Dec. 10, 1911. The complete address will be published in a forthcoming number of the Journal of the New England Water Works Association.

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It is the custom for the President to speak to you at the annual meeting, upon some serious matter. Last year, our President gave us a most interesting survey of the whole field of water-works business throughout the civilized world. Today, I choose a narrower subject, namely: "The Management of Water-Works." I shall refer particularly to water-works under municipal ownership, and I wish to consider the matter along somewhat broad lines.

The ownership and operation of water-works by cities is a kind of municipal trading. That is to say, it has nothing to do with government, but is, on the other hand, engaging in private business by a public body, which business might otherwise be performed by private parties.

In the beginning of the water-works business in America, private companies played a large part, and many important works are still owned by companies; but as time has gone on, more and more undertakings have passed into public ownership, until a great majority of water-works plants are now owned by municipalities. In general, the management of publicly-owned water-works has been good, and has produced results satisfactory to the water takers, and not burdensome to the taxpayers. No doubt mistakes are made in municipally-owned works, and some of these would be avoided by company management, but I doubt if the losses growing out of them would exceed those to be reasonably expected with private ownership of corresponding works.

Taking it right through, the public ownership of water-works has been the most successful line of municipal trading thus far undertaken by American cities.

One fundamental reason for this is, that the water-works business is naturally profitable. The income is easily and certainly collected, and is regular from year to year. Water can generally be secured and furnished at so small a cost, that rates may be at once remunerative to the system, and not burdensome to the takers. It has thus been possible in American cities to collect all necessary money to conduct the business, and it has rarely been necessary to burden the taxpayers in supporting these undertakings. These conditions have made it easy to operate plants without incurring deficits, and with general satisfaction to the citizens, and have perhaps led to easy-going ways in some matters, where better business methods might have been adopted.

I propose to talk to you today about this general subject, and see if we cannot do something toward getting better methods adopted by the works with which we have to do. I know that some of you have already done a great deal in this direction, and methods of management have been introduced which are admirable, as relating to particular parts of some systems.

There was presented to us two years ago, an excellent paper on depreciation, as applied to the water-works business. Discussion brought out the fact that must have been known to nearly all of us, that systematic calculation and allowance of depreciation charges are rarely carried out in publicly-owned works. It may be said also, that privately-owned water-works have, as a rule, neglected to make systematic depreciation charges until during the last years, when the regulation of such corporations and decisions of the courts as to reasonableness of rates, have made them imperatively necessary. It is now recognized that in the financial management of a privately-owned water plant, the annual depreciation must be carefully calculated and allowed each year, and there seems to be no reason why corresponding calculation and allowance should not be made for a plant that is owned by a municipality.

The reform in regard to depreciation charges is a most important one, but it is only one of a whole series that might be made with advantage.

Take the case of profits, or the return upon the invested capital, or in the case of an old plant, the fair value of the property. I think it is often true that the water-works management is satisfied if a balance is left in the hands of the treasurer at the end of the year, after operating expenses and the interest on the bonded debt have been paid, and perhaps some money put into extensions. But is this the whole question? Why should not a plant earn a fair return on its value, regardless of the amount of its indebtedness?

There are cases where the bonds originally issued to pay for water-works construction have been paid off, where additional construction has been paid for from earnings, and where the department is free from debt. There are other cases, fortunately less common, where bonds have not been paid off, where the works are depreciated, and where the plant is not worth the amount of the bonded indebtedness. Most plants lie between these extremes.

Let us consider for a moment the case of the plant that is out of debt. It is possible to operate the plant so as to pay its way, and to make water rates so low that they will cover only operating expenses, and such other general expenses as have to be met, and water may be supplied at much less than cost.

Some people believe, no doubt, that this is the best way to manage the business, and that when works have once been paid for, the public may properly be given the benefit of this condition, and supplied with water at whatever rates less than cost prove to be feasible.

I am disposed to take another view of the matter, and to hold that no water-works system can be called really self-supporting that does not earn a reasonable return upon the whole value of the plant, regardless of its bonded indebtedness. Certainly, the rates that will suffice to make such return are as low as rates could be made if the business were now being taken up for the first time, and in case the rate of return or percentage on the capital is as low as is consistent with good municipal management, the rates

reached under this condition may be taken as representing the real cost of the service.

If a city has, by good management, or in any way, acquired a property which is valuable, and is capable, at fair rates, of producing a net revenue representing a fair rate of return on its value, is it not the duty of the municipality to manage it as any other owner of a trading enterprise would do, to secure the fair return that naturally grows out of the business, and use that return for the benefit of the citizens in any way that is proper? This view largely prevails in American cities, although it is not frankly recognized. There are many cases where the water revenue is turned into the general fund and serves to diminish the amount of money raised by taxation. There are cases where bridges and other municipal structures having no relation whatever to water-works, have been built with water-works money.

What I suggest to you today is, that this matter of accounting, which in the past has been of a most haphazard character, should be reduced to a definite basis, and standardized in accordance with sound business principles, but without defining too closely the rates of return that are to be earned, which I think should properly be left to the good business judgment of those having to do with the matter from time to time.

Then there is the question of taxation and free water. Why should public trading be done on different principles from private trading? Why should a water-works be exempt from taxation, and why should the water-works furnish free water for hydrants, schoolhouses, churches, and all other public and quasi-public institutions? Probably the underlying idea in many cities has been that the taxes that would otherwise be paid, might be taken as an offset for the free water furnished to the city, and that the two things would balance each other, and that it would save bookkeeping to let matters go without calculation.

But this certainly is not a good business basis. Why should not the water-works plant be assessed taxes on its reasonable value, and why should not collection be made for all the water and services that are rendered?

The Interstate Commerce Commission has done away with dead-head transportation upon railroads. This action was a wise one, for the pass system had been atrociously abused. It meant a drain upon the railroads that could only mean higher fares for those who paid. But were the passes upon the railroads more abused than the free-water arrangement is abused in the case of municipally-owned water-works? If passes are abolished on the railroads, why should not dead-heads be abolished in the water business? Certainly because a taker is another department of the city government, is not sufficient reason why it should be supplied with free water.

On the railroads in the old days, it was, no doubt, true that those who had passes caused more trouble and expense than other travelers. So, I think, in your water departments, you will find that the dead-head takers are, in general, those who waste the most water, and that it costs the most to take care of. That which costs nothing is treated with but little respect. The schoolhouses that are furnished with free water, will use gang closets or self-flushing closets to save a little money in plumbing, and the water will go pouring through them day and night, because the janitor has not sufficient interest to shut them off at night because it costs nothing.

Our water-works statistics relating to physical matters have been well standardized. Would it not be worth while to extend our form, to include information as to the value of properties, the amount of depreciation allowed, taxes paid and free water furnished, the net earnings, and the per cent. which these are of the values. To find out the facts is the first step. The laws and ordinances that will provide for bettering the conditions, may be logically expected to follow.

One reform that might naturally grow out of consideration of the business along these lines, would be better and more uniform schedules of water rates. I do not believe that there is any other line of business that has such great and unreasonable variety in its schedule of charges, as will be found in water-works.

We have had committees on water rates, and a great deal has been done to straighten up and eliminate these eccentricities, but much remains to be done. The business cannot be considered to be in satisfactory shape in any given case, until a serious effort has been made to find out what revenue is really required and to prepare a schedule of rates that will distribute that amount as fairly as it can be distributed, among all the different takers, keeping in mind reasonable limits of simplicity.

There are several different ways of approaching this subject that have merit. Following different ones in different cases results in rates that are not easily compared with each other. I suggest that it ought to be possible at this time to agree upon a general form of water rates that could be used in all cases, but with figures omitted, with the idea that they would be fixed in individual cases, to meet the requirements of the revenue to be produced, and the relative abundance or scarcity of water. Where water is relatively abundant, a larger part of the amount to be raised will naturally be placed upon the fixtures, and upon the privilege of having connection and having water available. Where water is relatively scarce, the amount to be raised will be proportioned in greater measure, or even altogether, upon the quantity of water taken by the various consumers.

Such a uniform schedule might be similar in its general form to the schedules with which we are all familiar. Under fixture rates, there would be specified all the fixtures that would be charged for, and the method of rating them would be defined once for all, but leaving the amount of charge to be made for each item to be determined according to the requirements of particular cases. Under meter rates, the point would be settled whether the gallon or the cubic foot was to be the basis of the calculation, whether minimum rates were to be used, or whether instead a fixed charge should be made for the service, as recommended by our committee some years ago, with an additional charge for all water used, and the question of sliding would be taken up as to whether the scale should slide, and if so, at what points, and those points would be fixed, but the rates for water, and for the minimum charges or for service charges, would be left to be fixed according to the requirements of each case.

Schedules made up in this way could be directly compared with each other, which is something that cannot be done with present schedules of water rates, except in rare cases—as all of us know who have had to do with the rates, when effort has been made to investigate them by judicial procedure.

I may mention another question in water-works management, that arises in the case of cities or towns lying close together, and supplied most conveniently from one system. Cases of this kind are always numerous, and are especially so in the more densely settled parts of the country, as in New England. There is the case of the suburbs of a larger town, and the case of several towns lying near together, where the most available source of supply is at some distance, and where a single system would best serve all. This is a phase of water-works business where municipal ownership, up to the present time, has been relatively weak. The company form of management has had a distinct advantage under these conditions, because it knew no city lines, and could use one system, as far as it was physically advantageous to do so.

In Maine, water districts have been formed, the boundaries of which followed the limits of the territory that could be conveniently supplied with one system of works, rather than political boundaries. This plan has also been used in other places in America, in Europe, and quite generally in Australia, and it has been, on the whole, one of the most successful means dealing with this phase of the question.

The Metropolitan water district here in Boston is, perhaps, the most conspicuous case of a successful solution of this problem, but in this case the state took a hand, so that the works as they stand

are quite as much a state affair as a municipal undertaking.

In other cases, especially in the case of suburbs, the works of a city have been extended in adjoining country, or water has been sold wholesale. In other words, the municipality has been given leave to extend its trading beyond its own boundaries. Arrangements of this kind have been frequent, and are likely to be still more so, and in case one of the towns greatly predominates in size over the others, there is much to be said in favor of this arrangement. But there are many other cases where several municipalities have independent works, and are so situated that physically one system would better serve than several independent ones. The water problem may be the only one that draws these particular municipalities together, and coöperation between them in the line of economical development is often difficult, or seemingly impossible. This is one of the most interesting problems to be solved in the question of municipal ownership.

# Letters to the Editor

## The Recall Applied to an Engineering Board: The Pittsburg Subway Ordinance

Sir—Your editorial article of Dec. 28 entitled "Drastic Recall Provisions for a Board of Engineers," and referring to the ordinance pending before the Pittsburg City Council in the matter of a franchise for a subway, seems to call for some explanation. The unfailing fairness which characterizes ENGINEERING NEWS is a sufficient assurance to all its readers that no injustice was intended. But it is evident that all of the facts were not before the editor. And as one of the interested parties I beg your leave to supply a few.

The curious constitution of the proposed Board of Engineers might, in most circumstances, be justly subject to such criticism as has been made upon it. But it was the result of a compromise. It was not done to accommodate franchise bidders, for at the time when it was adopted there was but one subway company willing to undertake the task on any terms. The Pittsburg Subway Co. did not ask for representation on that board until the city authorities insisted upon giving to that board a very complete control over both maintenance and operation of the property; to such extent that no company could undertake the work without having at least an equal representation on the board. Under the peculiar laws of Pennsylvania covering this matter, whatever authority the city could exercise through such a board would be a clear gain for the public. So, when the company refused to submit itself entirely to the board's control without having a representation on the board, the joint representation was preferred by the city authorities as the better way.

I send you herewith a copy of the entire ordinance, in which it will appear that no veto power is reserved to the company. So long as the city insists upon exercising a very large control over a property in which it does not invest a dollar, the people who put up a large amount of capital for such purpose will naturally want a representation on the board.

E. K. MORSE,
Chief Engineer, Pittsburg Subway Co.
Commonwealth Bldg., Pittsburg, Penn.,
Dec. 29, 1911.

[The clauses quoted by us in our issue of Dec. 28, 1911, are the same as the corresponding clauses in the copy sent by Mr. Morse. The veto power to which we referred lies in the express authorization to either party to discharge two members of the supervisory board of three engineers. This condition is aggravated by the fact that the chairman of the board may be removed by either party, i.e., by either the subway company or the mayor, and perhaps by the city council. For this reason we remarked on the instability of the board.

The proposed ordinance is peculiar in other clauses than those we quoted when commenting on the "recall" provision for the board of supervisory engineers. It will suffice to quote two clauses, which have a bearing on the powers and responsibilities of the board of engineers:

(1) The duties of the board, beside approving the detail plans for the work, include, among other things, the very broad functions described as follows:

> All matters affecting or touching the operation of said railway or the administration of the affairs of the company shall be subject to the inspection and approval of said board.

What this means is doubtful. It suggests, for example, that the board might even assume to pass upon the appointment of the managers and operating officials of the company, since such appointment is certainly a matter "affecting the operation of said railway or the administration of the affairs of the company."

It is not at all surprising that the company should insist upon controlling a board which is given such broad and vaguely defined authority; and the question we would raise is the wisdom of bestowing such a measure of authority upon a board and then giving the company over which the control is exercised power to discharge a majority of the board whenever the board's decisions do not suit the company.

Further study of the ordinance shows other features which bid fair to lead to trouble in the future. For example, the ordinance stipulates that the gross earnings of the company are to be applied first to the payment of interest on the company's bonds and, second, to the payment of the operating expenses. So long as the earnings are sufficient to meet these requirements, it makes no difference which is paid first, although, as a practical matter, we suspect that money would have to be taken to meet the weekly or monthly payroll, whether there was enough in the treasury to pay the next due bond coupons or not. If the company reaches the point that it cannot pay both its operating expenses and bond interest, it will do the bondholders no good to have the company left without funds sufficient to keep the road running.

The ordinance continues:

> Out of any balance of income, ½ of 1% per annum on the approved cost of construction, to be placed in a sinking fund to be used solely for one or both of the following purposes, and for no other purpose whatever, viz:
>
> (a) For the purchase of the property of the company, as herein provided, and redeeming or paying of bonds charged thereon.
>
> (b) For the building of extensions or improvements, at the option of the city.

Apparently from what follows, "purchase of the property of the company" means purchase by the city, so that this half of one per cent. on the cost goes to benefit the city. If, however, this sum were applied to the building of extensions, these would be owned by the company.

It would seem to us that Pittsburg could study to advantage the experience of Boston and of Chicago and even of New York and Philadelphia in adjusting the relations between the city and subway building and operating concerns. A thorough revision of the ordinance may save expensive litigation in future.—ED.]

Issued Weekly by

The Engineering News Publishing Company

JOHN A. HILL, Pres. CHARLES WHITING BAKER, Sec'y.
ALFRED E. KORNFELD, Vice-Pres. W. W. MAYER, Treas.
GEORGE H. FROST, Chairman Board of Directors.

505 Pearl St., New York.
1138 Monadnock Block, Chicago.
Home Life Building, Washington, D. C.
Z. P. Maruya & Co., Ltd., Tokyo, Japan.

CHARLES WHITING BAKER, M. N. BAKER,
E. E. R. TRATMAN, F. E. SCHMITT,
Editors.

Subscriptions payable in advance, $5.00 a year for 52 numbers, including postage in the United States, Mexico, Cuba, Porto Rico, Hawaii, or the Philippines, $7.00 in Canada.

To foreign countries, including postage, $9.00 or its equivalent, 36 shillings: 36 marks: or 45 francs.

Notice to discontinue should be written to the New York Office in every instance.

Advertising copy should reach New York Office by Thursday of week before date of issue.

Entered at New York Postoffice as mail matter of the second class.

CIRCULATION STATEMENT

During 1911 we printed a total of 931,958 copies.

Of this issue 18,500.

None sent free regularly, no returns from news companies, no back numbers kept beyond current year.

# Engineering News

## Meager Compensation for Engineers

On a water-supply system, which cost over three-quarters of a million dollars, and is described elsewhere in this issue, the total engineering expenses from the preliminary surveys at the start to supervision of construction until final completion amounted to the sum of $14,259, or less than 2% of the cost of the work! And of this $14,529 no less than $6000, or nearly one-half, went to the consulting engineers as fees for passing upon the plans for the work.

Take out the consulting engineers' fees and the entire compensation to the engineers who designed the entire work and supervised its construction, including all expenditures for surveying and drafting, were less than 1% of the cost of the work.

In contrast with this, the lawyers who rendered service in the purchase of some 2200 acres of land for the reservoir site received a fee of $5000, or about 3½% of its cost.

The city recognized that competent legal service was essential to secure a good title in the purchase of land and was willing to pay for the ability requisite to such service. When it came to the design of a reservoir and water-supply system to cost three-quarters of a million dollars, it was assumed that the technical knowledge required to so plan such a work that it would be safe and economical was worth little more than the day wages paid to a union bricklayer or a locomotive runner.

Does the public really think that it can purchase engineering service below cost permanently and not be compelled to suffer for it in the end? We have recorded in these columns recently notable examples of what sometimes results from the policy of buying cheap engineering and as little of it as possible.

But the answer will be made, we presume, that such civil-engineering work as the building of a water-works reservoir is a very simple proposition which any engineer can accomplish well enough, so that there is no reason why the public should pay "fancy prices" for engineering on such a structure.

It happens that as these lines are being penned an illustration* is brought before us which bears directly on this question. In the construction of the Vyrnwy Dam, in Wales, the engineer-in-charge devoted an unusual amount of time and money to underground explorations of possible sites for the dam. As a result, the site finally adopted was removed a quarter of a mile from that first selected, with a resultant saving of over a million dollars in the cost of construction.

This is only an isolated example of many that might be given to show what poor economy it is to be parsimonious in the purchase of engineering.

The city which bought its engineering work at the very low price noted above was in Texas. Another example of saving at the spigot in engineers' salaries comes to us from a city in northern New York.

This city has a population of nearly 12,000, and there are 33 miles of streets and 22 miles of sewers to be maintained. The Superintendent of Public Works, who has charge of this work, receives a salary of $37.50 per month, and he says very pertinently in his report:

> It shows that the people do not see, or do not judge, this work intelligently, and also shows the small reward offered for public service—a career uncertain and precarious. If a public official performs service needed, he deserves pay sufficient. Occasionally, a fairly good man's necessities may compel him to accept such a salary, to tide over financial distress, but the entire system is wrong; for the city has to foot the bills of incompetency. Competent public servants paid a fair salary are the cheapest in the end. The construction, maintenance and operation of streets, sewers, parks, bridges, sidewalks and other correlated work make the appointment of a city engineer a necessity. Such appointment should be made for a term of years, and entirely removed from the scope of politics.

This Superintendent of Public Works also acts as superintendent of the city water-works, and this plant is managed on a similar penny-wise plan, as is shown by the following further extract from the report:

> The superintendent of your water-works receives thirty-seven dollars and fifty cents ($37.50) per month for the supervising, construction, maintenance and operation of a $1,000,000 water-works plant. Superintendents have been largely the appointees of dominating influence, and while you have saved $100 per month at the spigot end of the transaction you have lost $1000 per month at the other end.

*From a paper on "The Geology of Dam Trenches," by Herbert Lapworth, Assoc. M. Inst. C. E., St. Stephens House, Westminster, London, read before the Association of British Water Engineers in May last.

## An English Society of Consulting Engineers

It is noteworthy that almost simultaneously with the organization in the United States of a special society for engineers engaged in private practice (The American Institute of Consulting Engineers) an English society has been formed on very similar lines.

In both countries, the large majority of the engineering profession in all its branches carry on their engineering work as the salaried officers or employees of some private corporation, or of some government body; or else they are engaged in business on their own account as manufacturers or contractors.

A comparatively small percentage of the engineering profession is engaged in independent private practice. Those engineers who are engaged in this class of work have felt the need of some compact organization limited in its membership to engineers of this class and thereby able to adopt rules for uniform conduct. The organization of these new societies involves no assumption of superiority to members of the profession engaged in other branches of work. Such an assumption would be absurd, since there is a constant interchange going on; men are leaving salaried positions for private practice, while others give up their own offices to receive some appointment. Nor is the organization of these societies necessarily any reflection upon the national engineering societies, which are necessarily organized on a basis broad enough to include all classes of engineers.

While preliminary work looking to the organization of the English society has been in progress nearly two years, its formation was definitely decided upon at a meeting held last fall. The first formal meeting is to be held on January 15. It is of interest to note the qualifications which have been fixed for membership in

the society and also the rules proposed to govern professional conduct. We reprint them from the London *Times* of Dec. 27, as follows:

A member must fulfill the following conditions: (a) He shall be in practice as a consulting engineer, either individually or as a partner of a firm of consulting engineers; (b) shall be of such standing as, in the opinion of the committee of the association, entitles him to admission to the association; (c) shall be a full member of the institution representing the particular branch of the profession in which he practices; (d) shall not be a member of, or a partner in, or an agent for, any contracting or manufacturing firm or company or business with which he may have occasion to deal on behalf of his clients; (e) shall not be a director or employee of, or be an agent for, any company doing engineering insurance work; and (f) shall not be connected with any company or business who advertise or canvass for consulting work.

The rules which relate to the conduct of members are as follows: (1) A member shall act in all professional matters strictly in a fiduciary capacity with regard to any clients whom he may advise, and his charges to such clients shall constitute his only remuneration in connection with such work. (2) He shall not accept any trade commissions, discounts, allowances, or any indirect profit in connection with any professional work on which he is engaged. (3) He shall not, without disclosing the fact in writing to his clients, be a director of, or shareholder in, or have a financial interest in, any contracting or manufacturing firm or company or business with which he may have occassion to deal on behalf of his clients. (4) He shall not receive directly or indirectly any royalty, gratuity, or commission on any patented or protected article or process used on work which he is carrying out for his clients unless and until such royalty, gratuity, or commission has been authorized in writing by those clients. (5) He shall not act for a new client to the prejudice of an existing client. (6) He shall place orders explicity on behalf of his client and not on his own behalf. (7) Except at the request of the client he shall not be the medium of payments to any contractor or business firm, but shall only issue certificates for payment by his client. (8) He shall not knowingly accept professional work in connection with which another member has been appointed, unless either formally notified by the client of the termination of the previous appointment or else in collaboration with the other member. (9) He shall not advertise directly nor indirectly for professional employment, nor shall he answer any advertisement for a consulting engineer. (10) He shall not solicit professional work either directly or indirectly or by an agent, nor shall he pay by commission or otherwise any person who may introduce clients to him. (11) He shall not conduct himself in a manner, nor act in any capacity, nor hold any appointment, which in the opinion of the committee of the association prejudices his position as a consulting engineer.

## Statistics of Derailments Due to Defects in Railway Tracks

The annual report of the Interstate Commerce Commission, just issued, contains a table showing the derailments which have occurred during the ten years ending June 30, 1911, as a result of defects in railway track. We reprint the table below, as the figures it presents are worth the careful study of engineers.

That there has been an increase in the number of derailments due to defective track much greater than would be accounted for by the increase in mileage of road and volume of traffic which has been made since 1901 is evident on the face of the figures, even when allowance is made for some incompleteness in the figures given for the earlier years.

The Commission prints the table without comment beyond the mere statement that "the construction of cars and locomotives is tending toward an ever-increasing standard of dimensions without a proportionate betterment of track conditions." That the increases in weight of rolling stock and in speed of freight trains are important factors in the increase of railway-track defects will be agreed by all engineers. In view of this increase in rolling-stock weight and train speed, the increase in the number of derailments due to broken rails is certainly no greater than would naturally be expected.

It is remarkable that bad ties should be responsible for so few accidents when one recalls the very large proportion of railway track which is laid with ties of advanced age. On the face of the statistics, only two persons were killed in ten years on all the railways of the United States by derailments caused by bad ties. These figures, however, may be slightly misleading, as the accidents assigned to spread rails are doubtless in many cases due to the fact that the ties were in too poor condition to hold the spikes. Even with these included, however, the total casualties are surprisingly small.

It is of interest to note that the number of casualties from "irregular tracks," which means, doubtless, tracks not kept in good line and surface, is as great as the total number of accidents due to bad ties and spread rails.

While the number of casualties is great enough to deserve serious study, it is, on the other hand, interesting, by way of comparison, to note that the total number of persons killed in ten years on all the railways of the United States due to defective track is less than the number of persons killed on the streets of New York City alone in the single year 1911, by automobiles, street cars and other vehicles.

## A Proposed Federal Commission on Industrial Relations

A petition was presented to President Taft, on Dec. 30, urging the creation of a Federal commission on industrial relations.

This petition deserves more than passing notice by reason of the names which are attached to it. Among the list of signers are the names of men who rank as the highest authorities in economics and social science. We need mention only such names as those of Prof. E. N. Carver of Harvard University, Garrett Droppers of Williams College, Irving Fisher of Yale University, Ernest Freund of the University of Chicago, Jeremiah W. Jenks and W. F. Wilcox of Cornell University, A. S. Johnson of Leland Stanford University, Simon N. Patten of the University of Pennsylvania, Edward A. Ross of the University of Wisconsin, and E. R. A. Seligman of Columbia University. The list of signers also includes such leaders of public thought as Lyman Abbott, Edward P. Devine, Samuel M. Lindsay, George Foster Peabody, James B. Reynolds, William Jay Schieffelin and Stephen S. Wise.

DERAILMENTS DUE TO DEFECT OF ROADWAY ON RAILWAYS OF THE UNITED STATES FOR 10 YEARS ENDING JUNE 30, 1911

[Years 1908, 1909, 1910 and 1911 do not include accidents on electric railways]

| Year | Broken rail | | | Spread rail | | | Soft track | | | Bad ties | | | Sun kink | | | Irregular track | | | Miscellaneous | | | Grand total | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Persons | | | Persons | | | Persons | | | Persons | | | Persons | | | Persons | | | Persons | | | Persons | | |
| | Number | Killed | Injured | Number | Killed | Injured | Number | Killed | Injured | Number | Killed | Injured | Number | Killed | Injured | Number | Killed | Injured | Number | Killed | Injured | Number | Killed | Injured |
| 1902 ..... | 78 | 5 | 207 | 60 | .. | 132 | 50 | 3 | 44 | 8 | .. | 6 | 9 | .. | 11 | 85 | 3 | 79 | 257 | 9 | 235 | 547 | 20 | 714 |
| 1903 ..... | 150 | 12 | 204 | 108 | 6 | 94 | 101 | 2 | 90 | 14 | 1 | 13 | 4 | .. | 9 | 131 | 5 | 110 | 315 | 22 | 299 | 821 | 48 | 819 |
| 1904 ..... | 176 | 9 | 139 | 115 | 2 | 107 | 95 | 5 | 106 | 25 | .. | 5 | 13 | .. | 10 | 151 | 3 | 103 | 291 | 14 | 246 | 866 | 33 | 716 |
| 1905 ..... | 201 | 4 | 465 | 168 | 7 | 183 | 99 | 6 | 111 | 19 | .. | 36 | 15 | 5 | 101 | 154 | 10 | 266 | 351 | 18 | 284 | 1,007 | 50 | 1,446 |
| 1906 ..... | 220 | 7 | 635 | 168 | 2 | 146 | 180 | 4 | 166 | 25 | .. | 25 | 13 | 1 | 9 | 232 | 8 | 226 | 449 | 16 | 401 | 1,287 | 38 | 1,608 |
| 1907 ..... | 308 | 12 | 699 | 206 | 5 | 166 | 182 | 5 | 216 | 45 | .. | 16 | 18 | 1 | 40 | 272 | 5 | 230 | 497 | 30 | 616 | 1,528 | 58 | 1,983 |
| 1908 ..... | 238 | 16 | 433 | 200 | 1 | 164 | 151 | .. | 167 | 42 | .. | 43 | 28 | 1 | 93 | 211 | 6 | 189 | 545 | 21 | 472 | 1,415 | 45 | 1,561 |
| 1909 ..... | 196 | 5 | 498 | 130 | 2 | 94 | 114 | 4 | 77 | 36 | .. | 5 | 14 | .. | 14 | 175 | 3 | 96 | 315 | 9 | 376 | 980 | 24 | 1,160 |
| 1910 ..... | 243 | 24 | 369 | 171 | 7 | 152 | 110 | 1 | 250 | 31 | 1 | 12 | 28 | .. | 33 | 202 | 3 | 225 | 336 | 6 | 290 | 1,121 | 42 | 1,331 |
| 1911 ..... | 249 | 12 | 463 | 153 | 4 | 192 | 108 | 1 | 128 | 41 | .. | 17 | 30 | 3 | 62 | 179 | 5 | 130 | 465 | 32 | 568 | 1,225 | 57 | 1,560 |
| Total .... | 2059 | 106 | 4112 | 1477 | 36 | 1430 | 1190 | 31 | 1355 | 286 | 2 | 178 | 172 | 12 | 382 | 1792 | 51 | 1,654 | 3,821 | 177 | 3,787 | 10,797 | 415 | 12,898 |

Two weeks ago in these columns, in discussing present disturbances in economic, social and industrial conditions, we suggested the idea of ascending a mountain height, from which a broader view could be obtained than is possible when one looks only at the things close at hand. It is beyond question true that such men as those whose names are attached to this petition are in position to gain a far broader and more accurate view of social conditions than is possible to the ordinary man.

In the petition presented by these distinguished economists and public men, they allege that the present undercurrent of social unrest and the deep sense of social injustice which is abroad in the land constitute a grave menace to our institutions. The following quotation contains the most important recommendation of the petition:

We want light on that larger lawlessness which is beyond the view of the criminal courts. This is a matter of public defence in which we, as a people, should, if necessary, invest as much money as we put into a battleship. We appeal to the federal government to create a commission, with as great scientific competence, staff, resources and power to compel testimony as the Interstate Commerce Commission:

1. To investigate (and on this point make a preliminary report within six months) conditions of labor during the last six years in the structural iron trade, including in the study the organizations of employers and employees, the methods and purposes of each, and the relations of each to the other.

2. To gage the breakdown of our machinery of industrial government by tracing the trend of law and judicial decision through state and federal courts with respect to labor causes (the boycott, the picket, the injunction, the strike); and to examine the exact economic and legal status of the union, the union member, the nonunion man, the strike breaker, the tenant of a company house.

We heartily endorse this petition and earnestly hope that Congress and the President may see fit to act upon it without delay. The question it raises are of far greater importance than the discussions concerning party candidates which attract so much attention nowadays.

It is worth emphasizing that in the appointment of such a commission, the United States would simply be following the lead of other industrial nations. The same problems which are becoming so menacing here have already forced action in every other great industrial nation, and measures for industrial conciliation and for the relief of economic injustice have made far greater progress in other countries of the world than in the United States.

It is far easier to check a fire when it first starts than after it has gained headway. It will be far easier to establish industrial peace at the present time than after some nation-wide strike has fanned the fire of class hatred into a conflagration.

## The Burning of the Equitable Building in New York City

Twenty-five years ago no building in New York City was considered more safe from destruction by fire than the Equitable Building. In its construction no expense was spared and the intention of its designers and builders, without doubt, was to create a monumental building which should endure for centuries.

Experts understand that an enormous advance in the art of fireproof construction has been made during the little more than a quarter century since the Equitable Building was erected and know the defects which experience has developed in the older construction. By the general public, however, the Equitable Building has still been regarded as a model of permanence, durability and safety.

In the early morning of Jan. 9, a small fire started in some rubbish near one of the kitchens of a restaurant on the ground floor of the building. The fire was probably started by the careless throwing away of a lighted match. The blaze was discovered soon after it started by some of the watchmen in the building and was fought by the building's own forces under direction of its chief engineer for some twenty minutes in the confident belief that the fire could be extinguished without calling in the fire department, and causing resultant water damage. Twenty minutes after the start of the fire a policeman in the street rang in a fire alarm, and two and a half minutes afterward the first engine was attaching its hose to the street hydrant. Other alarms were turned in until nearly the entire fire-fighting force of New York and Brooklyn was concentrated around the building. But in this brief twenty minutes before the first alarm was rung, the fire gained such headway, escaping up the elevator shafts and spreading on the upper floors of the structure, that within a short time the firemen were driven out of the building. So rapid was the spread of the flames that several employees of the building were caught and burned to death before they could escape.

In some respects the conditions were especially favorable for fighting the fire. It started early in the morning, when the downtown streets and the building were deserted and there was nothing to hinder the firemen at their work. The Equitable Building, moreover, was a comparatively low structure of only eight stories and was surrounded on all sides by buildings of much greater height, from the roofs of which it was possible to send hose streams directly into the burning structure.

It doubtless never occurred to the hundreds of tenants who have occupied the Equitable Building since its construction that they were in the same danger of a terrible death from a quick-spreading fire before they could escape from the building, which menaces most of the tenement dwellers and factory workers in New York City. But, in the light of what actually happened on the morning of Jan. 9, there can be no doubt that if the fire had broken out during business hours, many occupants of the building would have delayed their escape, believing the building perfectly secure against fire, and would have been caught by the rapidly spreading flames.

The rapid destruction of the Equitable Building is well worth attention because it is an important object lesson as to the fire danger in the "monumental" type of buildings which were erected under the direction of the best architects in the country twenty years or more ago. It is true that the owners of the Equitable Building had practically decided upon its demolition, but this was not because they appreciated its dangerous character as a fire risk. It was because the thick walls and small windows of the structure, which was built just before the days of steel-cage construction, made the offices dark and undesirable and also because the structure had so few stories that it could not yield enough rental to pay a fair rate of interest on the very valuable land which it occupied.

It is, of course, true that the destruction of the Equitable Building is only one of numerous examples which prove the fire risk that exists in connection with some of the finest structures which were built by the most noted architects of a quarter century or more ago, and which were considered at the time of their construction to be absolutely safe and permanent. Among the recent cases of fires in notable buildings of this class are the fire which destroyed the Cincinnati Chamber of Commerce Building (ENGINEERING NEWS, Feb. 2, 1911) and the fire in the New York State Capitol buildings at Albany, on Mar. 29 last.

Other examples might be cited, but the point we would emphasize is that the need of the high-class structural engineer in building design was barely beginning to be realized when the so called "monumental" structures of a quarter century ago were designed. The leading architects of that day were nearly as ignorant of the principles of safe and really fireproof building construction as were their clients who sought to build first-class structures. Structural engineering, indeed, was only beginning to be recognized as an important branch of the profession.

It is such notable occurrences as this destruction of a building supposed to be so safe against fire that its vaults held a greater value in securities, probably, than any other in New York City, which impress on the general public the enormous advance which has been made in the

art of building construction through the efforts of structural engineers. It ought to impress the lesson, also, that the work of the structural engineer and the specialist in fire prevention is just as important in the design of a building as is the work of the architectural designer. It is absurd to spend millions to secure beauty in architectural detail and elaborate finish, and refuse to spend the few thousands needed to make the structure on which this wealth of ornament is lavished safe against the attack of fire.

While full information as to the details of construction of the Equitable Building are not yet available, it is believed that the main cause which brought about the fall of the floors near the Broadway front of the building was the lack of effective fireproofing on the bottom flanges of the floor beams. It is evident also today that a building with its beams simply resting on masonry sidewalls is unstable and unsafe when attacked by fire compared with steel-cage construction in which the whole framework is riveted firmly together.

What really caused the destruction of the Equitable Building, however, was the great amount of wood finish used in its construction and the unprotected elevator shafts and stair wells, which spread the fire from the lower story where it originated to the upper floors.

Experience with a great number of fires in so called fireproof buildings has demonstrated that there is no building, no matter how constructed, in which fire may not break out and spread, even though the building's framework and finish be of material entirely indestructible. There are in practically all buildings enough contents of a combustible nature to spread the flames. To say that a building is fireproof, therefore, means simply that it is of such construction that a competent fire-fighting force can extinguish the flames faster than they can can spread.

As one views the tottering granite walls of the Equitable Building ruin, which, notwithstanding the fact that they were exposed to only a moderate degree of heat, are so unstable and unsafe that the streets adjacent to them are closed to the public, it is interesting to recall the controversy waged with such earnestness twenty to twenty-five years ago, as to the relative merits of the steel-cage construction then forcing itself on public attention, and the older type of "monumental" building with its self-supporting masonry walls.

That the steel-cage type won was due, not to lack of faith in the safety of the older "monumental" structure, but to the fact that the steel-frame structrue was far cheaper to build and permitted much larger window openings to admit light and air. Even now, doubtless, the old-time masonry building would find strong advocates were it a question of erecting a building of unquestioned permanence; but to those who hold such a view, the Equitable ruin presents a lesson deserving unprejudiced study.

## Tunneling in Sand for a Subway Crossing under a Subway

The Fourth Avenue Rapid Transit subway in Brooklyn, New York City, now under construction, crosses Flatbush Ave. near Fourth Ave. just where the Flatbush Ave. station, the eastern terminal of the existing (Interborough) subway, is located. The Interborough subway is directly beneath the street surface, and the Fourth Ave. subway is required to pass under the station of the older subway. The contractors, Bradley Contracting Co., found it a serious problem how to carry on this undercrossing work safely and economically.

The plan prepared by the Public Service Commission for the work at this point contemplated the use of the regular steel column-and-beam construction with concrete arch filling between the beams to form the roof and sides; the steelwork was complicated somewhat by several track crossovers, involving the use of girders spanning several tracks. To build such a structure would have required the excavation of practically the entire section, and the provision of adequate artificial support for the station and structure of the Interborough subway above. The crossing length of the new line is about 250 ft. (the crossing is on a skew and includes a curve) and the width of the structure is about 90 ft. The situation is rendered somewhat more precarious by the fact that the Fifth Avenue elevated railway runs along Flat-

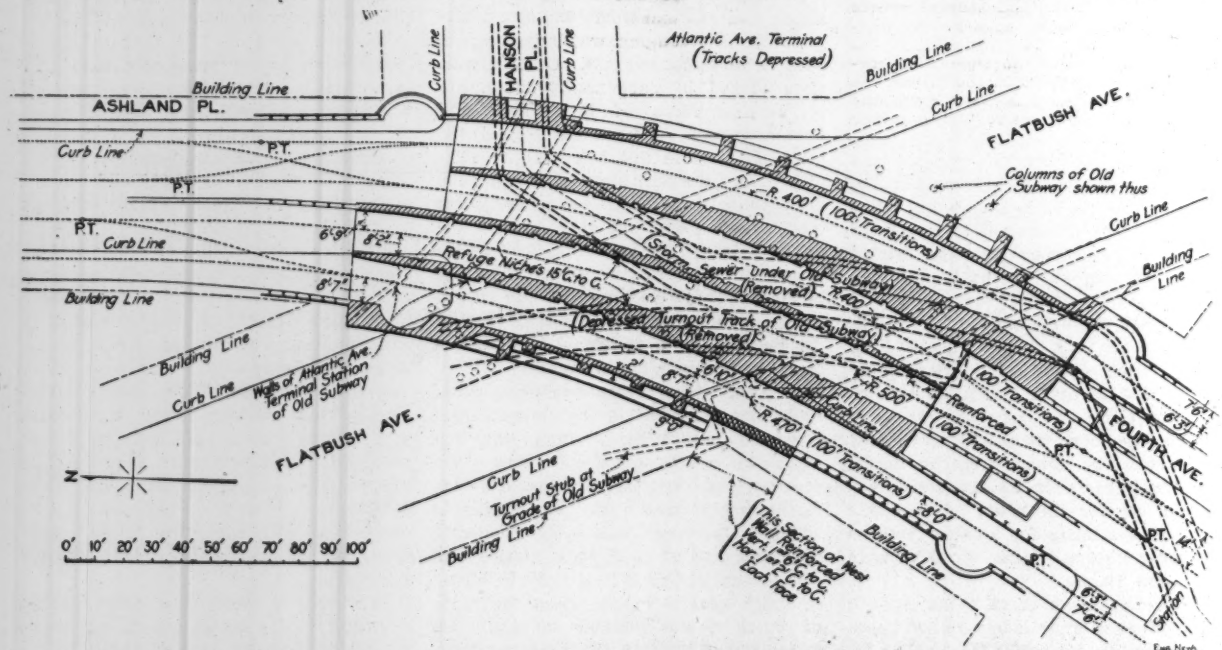
Atlantic Ave. Terminal (Tracks Depressed)
Building Line
Curb Line
HANSON PL.
ASHLAND PL.
FLATBUSH AVE.
Columns of Old Subway shown thus
P.T.
R. 400'
(100' Transitions)
Refuge Niches 15' C. to C.
Storm Sewer under Old Subway (Removed)
Depressed Turnout Track of Old Subway (Removed)
Walls of Atlantic Ave. Terminal Station of Old Subway
R. 500'
R. 470'
Reinforced
FOURTH AVE.
Turnout Stub at Grade of Old Subway
This Section of West Wall Reinforced Horizontally 2' C. to C. Each Face
0' 10' 20' 30' 40' 50' 60' 70' 80' 90' 100'

FIG. 1. PLAN OF FOURTH AVE. SUBWAY CROSSING UNDER ATLANTIC AVE. STATION OF INTERBOROUGH SUBWAY, FLATBUSH AVE., BROOKLYN

(An elevated railway extends along Flatbush Ave., and two trolley tracks occupy the surface of the street; these are not shown. The Fourth Ave. subway is shown in section; the Interborough subway above is shown in dash lines; the depressed crossover and the storm sewer shown in heavy dash lines were below the floor of the Interborough subway.)

bush Ave. and is carried on the roof of the Interborough subway. The load on the new structure to be built includes, therefore, the elevated railway, the street with its two surface car tracks, and the four tracks of the Interborough subway and station.

The contractor deemed the construction on the prescribed plan to be impossible. He therefore retained the firm of Jacobs & Davies as consulting engineers to advise on a feasible method of construction. These engineers presented a plan for constructing the crossing of concrete in wall-and-arch arrangement by tunneling. This plan, being approved by the Public Service Commission, was thereupon carried out by Jacobs & Davies, acting for the contractor, as managing engineers under a force-account method. Construction was begun in September 1911 and is now well advanced, so that its completion is expected in April 1912.

As this work is being visited by the American Society of Civil Engineers during its annual meeting this week, a short description of what has been done is opportune.

The special feature of difficulty in carrying out the tunneling scheme was the soil encountered. All the work is above ground-water level, and the soil is therefore dry. It was found to be a coarse, sharp, clean sand, absolutely lacking all cohesion, and running freely on account of its dry condition. Close-sheathed timbering was required at all places, and great care was necessary in setting forward the face sheathing to prevent running of soil and the consequent risk of settlement of the superincumbent subway, street and elevated structures. The inherent difficulties of such work were seriously aggravated by the vibration from the trains in the subway, which was plainly felt throughout all parts of the area of work.

The location of the structure is shown in plan by Fig. 1. The Fourth Ave. subway here turns southerly from Ashland Place into Fourth Ave., crossing Flatbush Ave. on a curve of about 400 ft. radius. The provision of a station just south of here, and the necessity for spreading the tracks to pass the station platforms, however, makes the conditions of curvature somewhat irregular. Advantage was taken of this fact to rearrange the curves of the four tracks slightly to suit the new concrete wall-and-arch design. The spread of the tracks gives room for fairly thick walls of concrete, amply able to carry the load above. The section, Fig. 2, transverse to the line of the new work exhibits the relation of the old and the new subway more clearly and shows also the general type of structure selected for the crossing.

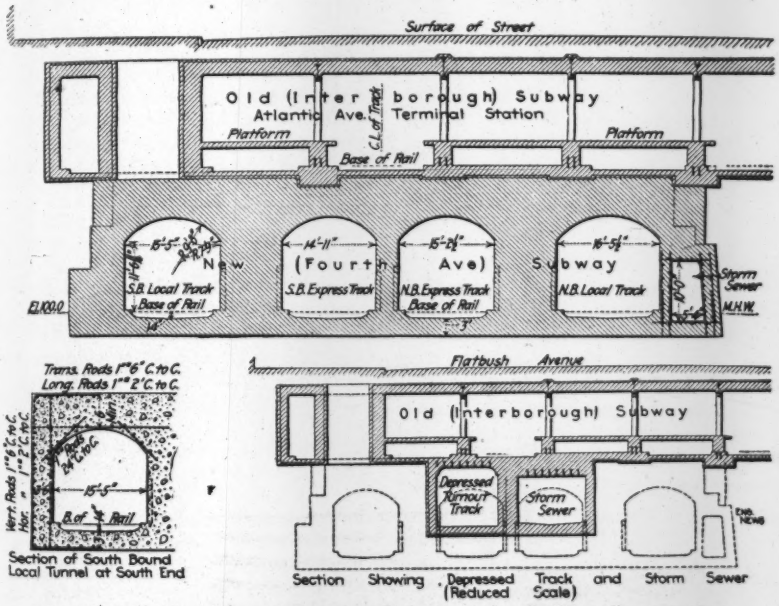


FIG. 2. CROSS-SECTION OF FLATBUSH AVE. CROSSING OF NEW FOURTH AVE. SUBWAY UNDER INTERBOROUGH SUBWAY

The reduced-scale section in Fig. 2 shows the location of two special structures under the floor of the Interborough subway, which complicated the execution of the work materially. (1) A depressed crossover track of the Interborough subway extended from the northerly of the four tracks down and under the floor, crossing southward into Fourth Ave. In conjunction with the initial stub of a similar (but not depressed) turnout from the southerly track, this was intended to provide for a future connection with a two-track subway in Fourth Ave. or elsewhere south of Flatbush Ave. Neither of the two turnouts was used at any time, and the depressed track had to be removed to construct the crossing of the Fourth Ave. subway. (2) A storm sewer extended alongside this depressed track, leading from Hanson Place to Fourth Ave.; it was normally dry but had a large cross-section to care for a considerable volume of storm drainage. It was originally an oval brick sewer, but the portion crossing Flatbush Ave. had to be rebuilt at a lower level when the Interborough subway was built. The new part, a rectangular concrete conduit under the floor of the subway, was built integral with the subway structure, its roof forming the floor of the subway. It also had to be removed in the construction of the Fourth Ave. work. In its place a concrete sewer was constructed by forming a rectangular hollow through the length of the east abutment wall of the new structure. At the southerly line of Flatbush Ave., it was carried by a cross connection under the subway floor to the old brick sewer on the west side of Fourth Ave.

### METHOD OF WORK

The tunneling work under the subway to construct the new subway was carried on as follows: On either side of the old subway and in the right-of-way of the new subway a shaft was sunk approximately to the level of the bottom of the new work. From either shaft a drift was excavated parallel to the old subway, thus crossing the entire width of the new work. The excavation and concreting work for the new subway was conducted from these drifts by running longitudinal tunnels or headings, driven from either end and brought to junction. As already remarked, all these operations had to be conducted with tight sheathing to prevent any movement of the soil.

The wall headings were carried 12 to 14 ft. high, and wide enough to include the wall and, where possible, a sufficient width alongside to permit of running a narrow-gage track for muck and concrete cars alongside the wall forms. As soon as the heading was holed through, forms were set up in it for the wall and concrete was placed up to the top of the drift, this being somewhat below the springing line of the arch. The five walls were not constructed simultaneously, but work on them went along as conditions permitted. Each heading was started as soon as the excavation of the drifts from the shafts reached the proper point, and some of the wall headings were through and the walls fully built to the top of the first stage before the last of the headings had been more than started. The diagram, Fig. 3, shows the wall work at the right.

After the construction of the lower walls, the second operation included: Excavating the arch space and shoring the structure above, placing forms for the arch, and concreting the entire space

above the forms and up to the floor of the Interborough subway. This was started as soon as the two walls of one trackway were completed. It was undertaken in short sections, only 14 ft. long, which permitted carrying the roof (i.e., the floor of the Interborough subway) by longitudinal I-beam crownbars supported on posts at either end. The crownbars were 18-in. I-beams placed about 24 in. apart; in concreting, the concrete was packed between them and around them in the endeavor to leave no void, but radial iron pipes were embedded in the arch concrete for grouting the minor voids.

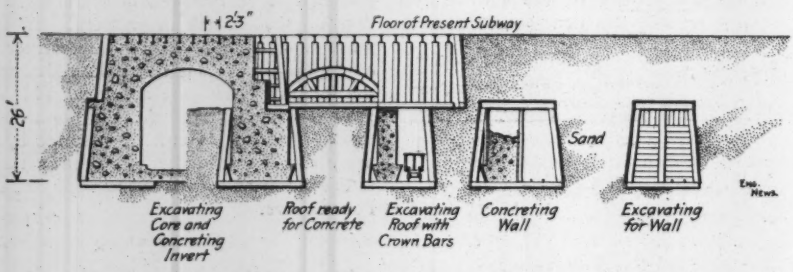


FIG. 3. COMPOSITE DIAGRAM OF THE SUCCESSIVE STAGES OF WORK IN THE FLATBUSH AVE. CROSSING OF THE FOURTH AVE. SUBWAY

The excavation of this arch space proceeded either from an end face or from an upraise, as local conditions dictated. The full width from center to center of wall was taken out in each case, this width varying from 20 to 25 ft., except that in the case of the outer (i.e., east and west) tracks the entire thickness of the abutment wall was included. The use of the crownbars kept the arch space free from all timbering.

The arch forms were segmental trusses, carrying lagging of 2x4 sticks laid flat, which successfully spanned the 4-ft. distance between trusses. Side-wall forms were carried far enough below the springing line of the arch to make a tight connection to the lower part of the wall previously laid. The concrete was deposited in the wall and arch in one operation, the work progressing upward and finally terminating with packing a drier mixture of concrete into the upper part of the space, between the I-beam crownbars.

The completion of the roof concrete ended the difficulties of the undertaking. Up to this time the core of earth in the four trackways remained. The last stage consisted in removing this core down to the level of the bottom of the invert and placing the invert concrete. The work in this stage involved no particular difficulties or risks. It was carried on in sections 20 to 25 ft. long.

Inasmuch as the great load coming from the structure is rather excessive for the bearing area at the foot of the walls alone, the design contemplated distributing the load through the invert to the entire area of underlying soil, and the invert on this account is designed very thick. In building the wall, the lower portion of the sides was flared outward, so that when the invert concrete was placed the invert section was held between the walls as a wedge, and thus was able to transmit upward pressure to the walls.

The work described above involved about 21,000 cu.yd. of excavation in place and about 12,000 cu.yd. of concrete. Shaft sinking was begun Sept. 11, 1911, and was completed within a week. Excavating the two lateral drifts occupied two weeks to a month. The last of the wall headings was completed during the past week, making a total of 3½ months for this part of the work. In the meantime, however, a large part of the wall concrete and about one-third of the arch roof concrete has been placed. The invert work has only been started. It is expected that all work will be completed by the end of April 1912.

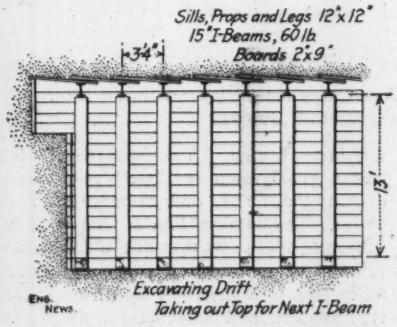


FIG. 4. SECTIONAL SKETCH OF HEADING TIMBERING

The great risk of the work lay in the possibility of settlement, due to running of the sand, under the great load from above and the vibration induced by the passage of trains in the Interborough subway and on the elevated structure. Had the soil been wet, with any tendency to run, the use of even more complex methods would probably have been required. In view of the total absence of water, the ordinary mining methods of tunneling could be used, but the noncohesive nature of the sand made it necessary to use extreme care to prevent any movement of soil. The lagging and face sheathing were kept close at all times, and salt hay was used freely to fill any opening or void. In this way it was possible to carry through the work with only trivial settlement of the structure above.

The risk of the work was illustrated, however, by an accident which occurred a few weeks ago, unfortunately causing two fatalities. Two workmen engaged at the face were overwhelmed by a rush of sand, due apparently to the face sheathing slipping down, owing to the removal of material at the base, which left the sheathing without vertical support and permitted the vertical breast-boards immediately under the crown timbering to be forced out and the sand to follow in a rush. This accident produced a large cavity, but fortunately its area was small enough that the floor of the subway overhead could bridge across. Traffic was discontinued on one track of the subway temporarily until the opening could be filled and new sheathing set and braced.

The method of conducting the face work in the heading is exhibited by the sketch, Fig. 4. Transverse I-beams support the roof lagging, which consists of needles driven forward over the forward I-beam to a point 3 or 4 ft. in advance of the face. The upper part of the face sheathing consists of vertical boards which are removed and set forward after the roof lagging has been driven ahead. The lower part of the face has horizontal arrangement, and the individual boards are set forward one at a time until the new face is completely gained, when they are braced with one or more immediate vertical supports. The face sheathing extends to the floor, but the floor is lagged only in exceptional instances.

In setting forward the roof, the sand is excavated under the lagging as soon as it has been driven forward, to permit an advance roof-beam to be placed. Since this roof-beam cannot be supported on posts until the entire face is set forward, it is carried temporarily by a pair of longitudinal beams suspended from the roof-beams to the back by special hangers and made tight with blocking. The advance roof-beam, supported in this manner, is blocked up under the forward end of the new length of roof lagging, with a 4-in. clear space to allow for driving the next set of lagging strips. In the sketch, Fig. 4, showing a longitudinal section of the heading, the beams for carrying the forward roof-beam are not indicated, but their use will be obvious.

The construction of this undercrossing was in direct charge of James Forgie, partner of the firm of Jacobs & Davies. The field superintendent for them was R. S. Courtney. Our illustrations are from plans and sketches furnished by them.

# The Destruction of the Equitable Building by Fire Jan. 9, 1912

The building of the Equitable Life Assurance Society at 120 Broadway, New York City, is shown by the two halftone views herewith as it appeared after its destruction by fire on Tuesday morning, Jan. 9, 1912. Fig. 1 is taken looking southeastward, with Cedar St. on the left and the Broadway front at the right, the American Surety Bldg. (100 Broadway) being in the right background at the southeast corner of Broadway and Pine St.

The northwest corner of the Equitable Bldg., in the foreground of Fig. 1, suffered more severely than most other parts of the structure. Here the Mercantile Safe Deposit Co. had its vaults in the basement story, behind the thick ice accretions seen in the view; two men were rescued from these vaults through the barred window here, opening on the sidewalk, and several others met their death in the vault rooms. Above, the floors collapsed in the entire corner portion, and the heavy stone and brick walls

FIG. 1. RUINS OF EQUITABLE BUILDING
(Taken Jan. 9, 1912. Looking Southeast from Corner of Broadway and Cedar St.)

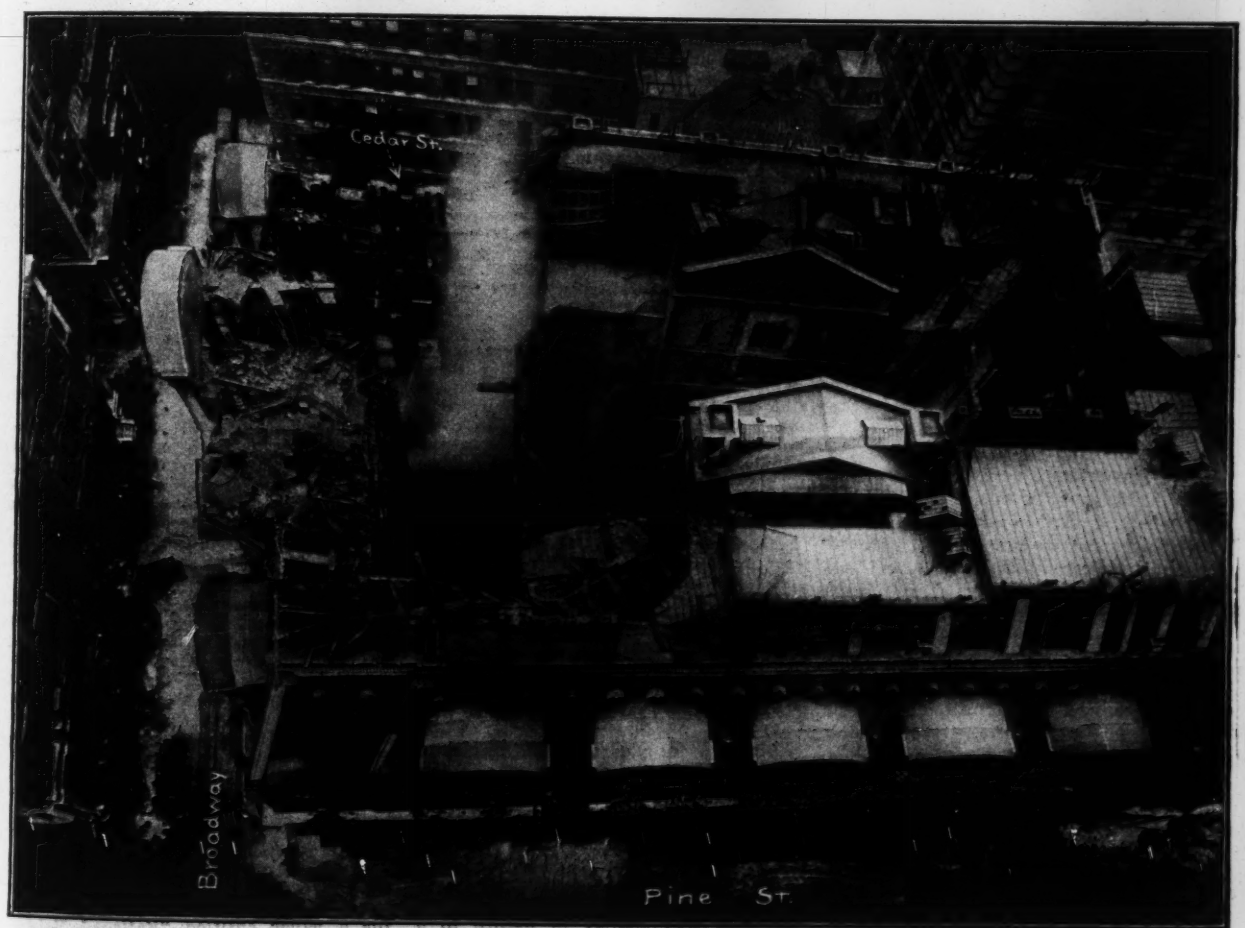


FIG. 2. LOOKING DOWN INTO EQUITABLE BUILDING AFTER THE FIRE

were left in threateningly unstable condition.

The view Fig. 2, looking down into the building from an upper story of the American Surety Bldg., exhibits the extent of the destruction more fully. In this view, Broadway is at the left, Pine St. at the lower border. A large light-court in the middle of the building separates the parts of greatest damage (on the west front) from the less damaged portions.

The building is about 168 ft. long on Broadway and 152 ft. on Nassau St., with a depth of 305 to 310 ft. Its height ranged from 110 to 150 ft., with a maximum of 12 stories. The central court, about 35x90 ft., extended up through the full height from a skylight at the second-floor level; in the northerly part were four smaller light-shafts.

Its construction was somewhat heterogeneous. The structure was built in several stages. In 1868 the earliest part was erected, this being the northwest corner section. Bearing walls, wrought-iron beams, and brick floor arches characterized its construction. The main portion was erected in 1885; this has hollow-tile flat-arch floors. The northeast and southeast corners, on Nassau St., were in effect independent buildings, and the southeast corner building was of steel-frame construction. Throughout, wood was used freely, not only for trim, doors, etc., but also for partitions. This with the large amount of paper and similar combustible material in the contents furnished fuel for the fire.

The spread of the flames was facilitated by the absence of protection of the vertical openings. The elevator shafts had open grill doors or (in some cases) were wholly open. The stair wells were generally open. The windows facing the light-courts were unprotected and had plain-glass panes.

Rapid spread of the fire, when once well started, was a natural consequence of these conditions, under the stimulus of the gale of wind which prevailed at the time. The collapse of the floors, on the other hand, was due to the fact that the lower flanges of the wrought-iron I-beam floor joists had no fireproofing, and the columns (cast-iron) also were not fireproofed.

The origin of the fire has been located in some waste paper in a basement room, ignited probably by a match carelessly thrown away. The burning of the paper was not noticed for some minutes, and attempts on the part of employees of the building to extinguish the fire made a further delay of nearly half an hour before an alarm was sent. The fire was beyond control when the first engines arrived.

A preliminary examination of the building was made two days after the fire by a Board of Survey formed, according to law, of one representative each of the Bureau of Buildings, the owner, and the American Institute of Architects. They reported the building unsafe:

> The walls are cracked, broken and out of plumb; parts of them have collapsed; many of the lintels are cracked; the roof and floor beams are warped and burned and in part collapsed; the interior woodwork is charred and burned; and the parts of the building standing are in an unsafe condition.

Fuller examination will be made as soon as the safeguarding work now in progress permits.

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**A French Aviator,** named Ruchonnet, was reported killed at Senlis, on Jan. 12, by a fall which was caused by an unskillful attempt at landing.

**An Explosion in the Mine** of the Parrish Coal Co., at Plymouth, Penn., Jan. 9, caused the death of six men, who were engaged in timbering one of the slopes.

**An Explosion of Natural Gas** in the basement of a two-story brick building, at Shreveport, La., Jan. 2, wrecked the building and badly injured six or eight persons.

**A Powder-Mill Explosion** at the new plant of the Du Pont Powder Co., at Wilpin, Minn., Jan. 11, wrecked the glaze mill and killed two employees.

**A Locomotive Boiler Exploded,** Jan. 5, in the round house of the Southern Pacific Ry., at Los Angeles, Calif. The engine was demolished and one end of the round-house was wrecked. One man was killed and another fatally injured.

**A Collision in France,** Jan. 6, at Bondy, about seven miles from Paris, killed six persons and injured 20 others. The accident is ascribed in press reports to a misplaced signal.

**A grade crossing accident** at Pearsons Station near Torresdale, Penn., Jan. 14, killed the six occupants of a horse-drawn carriage that was struck by an express train. The accident occurred on the tracks of the Pennsylvania R.R. The driver of the carriage had waited while a freight train passed and then started across the tracks only to be hit by the express.

**Spreading rails** are assigned in press reports as the cause of a derailment, Jan. 14, on the Cleveland, Cincinnati, Chicago & St. Louis Ry. near Carey, Ohio. The train was running at high speed on a down grade when a combination dining and day coach in the middle of the train left the rails. Two coaches overturned before the train could be stopped. Thirty-four persons were injured.

**A Butting Collision,** Jan. 8, at St. Vincent de Paul, Que., caused the death of four persons and the injury of eight or ten others. A train from Quebec, pulled by two locomotives, ran into a train from Montreal, which was standing on the main line at the St. Vincent de Paul station. The Quebec train was expected to take the siding at this point, but failed to come to a stop in time to prevent the collision. The accident is ascribed in press reports to the failure of the air brakes on account of the low temperature.

**An Explosion in a Sewer** at One Hundred and Seventeenth and Manhattan Sts., New York City, on Jan. 8, lifted the manhole covers in that vicinity. Windows nearby were broken and two people were badly bruised. It is believed that the explosion was similar in nature to a number which have occurred in New York City in the past few years. These were caused by the ignition of gasoline vapor in the sewers, the volatile liquid being carried there from automobile garages in the vicinity of the explosion. The ignition is credited to chance contact with some flame, coal or spark near a manhole, catch-basin opening or street-car conduit drain. (See Engineering News, Dec. 2, 1909.)

**The Typhoid Fever Outbreak at** Trenton, N. J., noted in our issue of Dec. 14, 1911 (p. 723), totaled 145 cases up to Dec. 31, 1911. There were 20 cases reported in October, 51 in November and 74 in December, but of the 145 cases for the three months only eight were reported in the two weeks ending on Dec. 31. We are indebted to Dr. Bruce S. Keator for the information just given, and also for the following statement regarding the treatment of the water supply with calcium hypochlorite:

> The plant was put into operation on Nov. 9, 1911, with a dose of 0.4 part per million. This dose was increased, on Nov. 28, to 0.7 part per million, and, on Dec. 3, to 0.8 part per million, where it remained until Dec. 27. On this date, because of heavy rains, the dose was further raised to 1.1 parts per million. A reduction was made, on Dec. 28, to 0.8 part per million, and the dose has there remained up to the present time [Jan. 5].

**A Recent Typhoid Fever Outbreak at** Sarnia, Ont., may possibly be due to a broken intake pipe, but indications that the accident may have taken place some time ago throw doubt on this view of the outbreak. A press dispatch, dated Dec. 29, 1911, states that a diver employed by the Reid Wrecking Co. found the intake pipe completely broken at a point 200 ft. from the shore, and dislocated by dragging to the north some 12 ft., thus admitting water liable to pollution. It is stated that the condition of the break indicated that it might have occurred some years ago, and that the intake pipe has not been inspected for the past three years. Somewhat vague reports of bacterial examinations of samples of water taken in Sarnia suggest that the typhoid outbreak may be due to some other cause than the public water supply, but the reports are too indefinite for drawing final conclusions.

**An Increased Freight Rate on Empty** cement sacks is under consideration by the Western Classification Committee and was taken up at a meeting held at the Hotel Galvez, Galveston, Tex., on Jan. 16. It is stated that the present classification of empty cement sacks at half fourth-class will be changed to second- or third-class. The increase was opposed by the Sack Committee of the Association of Portland Cement Manufacturers, of which Mr. Gordon Wilson, 72 West Adams St., Chicago, is chairman.

**The Hart, Schaffner & Marx** prizes for papers on economic subjects have been awarded for 1911 as follows: In Class A, the first prize of $1000 to Harold G. Moulton, Ph. B., Instructor of Political Economy in the University of Chicago, for a paper entitled "Waterways versus Railways"; the second prize of $500 to Harrison H. Brace, of Chicago, for a paper entitled "Value of Organized Speculation." Honorable Mention, to DeWitt C. Poole, Jr., State Department, Washington, D. C., for a paper entitled "Is the American Cotton Monopoly Secure?"

In Class B, the first prize of $300 was awarded to Homer B. Vanderblue, undergraduate in Northwestern University, for a paper entitled "Railroad Valuation."

**Panama Canal Excavation** during December totaled 2,439,276 cu.yd., a daily average of 97,571 cu.yd. for each of the 25 working days in the month. The rainfall was 1.19 in. During the month 110,265 cu.yd. of concrete were laid and 353,895 cu.yd. of fill placed in dams.

**Plate-Girders of Record Size** have been placed in a crossing of the Boston & Albany R.R. over the New York, New Haven & Hartford R.R. at South Worcester, Mass. They form part of the extensive track-elevation work of the Boston & Albany, at Worcester, which has been in progress during the past year. The crossing is four-track, and comprises five lines of plate-girders in two spans over the New Haven tracks and a truss span over Southbridge St. The longer of the two girder spans is 122½ ft. o. to o.; its girders are 10½ ft. deep and each weighs 170 tons. Longer plate-girders have been built in the past, but none of a weight approximating those of the present girders. An unusual feature of the detail construction of the girders is that rivets of 1⅛-in. diameter are employed. Careful trials of this size of rivet were made before it was adopted. Test rivets were driven through a set of plates and the assemblage was then cut through the middle of the rivets so as to expose the longitudinal section and show whether the rivets filled their holes in a satisfactory manner. These girders were manufactured by the Pennsylvania Steel Co., of Steelton, Penn., and were erected by the Lucius Engineering Co., of Pittsburg, Penn. They were raised to position on Sunday, Jan. 7, 1912. Two derrick cars were used for lifting them from the track level below to place on the abutment and the steel intermediate bent. Mr. W. F. Steffens, Engineer of Structures of the Boston & Albany R.R., was in charge of the design of this work, under the general direction of F. P. Freeman, Chief Engineer.

## Personals

Mr. W. W. Phelps has been appointed City Engineer of Santa Monica, Calif.

Mr. Otto M. Rau, M. Am. Inst. E. E., Chief Electrician of the Milwaukee Electric Railway & Light Co., has resigned, effective Feb. 15.

Mr. G. H. Hammond, of Gladstone, Mich., has been appointed Superintendent of Terminals at Duluth and Superior of the Minneapolis, St. Paul & Sault Ste. Marie Ry.

Prof. Filibert Roth, of the University of Michigan, has accepted the management of the forestry department of the New York State College of Agriculture of Cornell University.

Mr. Austin Burt, M. Am. Inst. E. E., formerly General Superintendent, has been promoted to General Manager of the Citizens' Gas & Electric Co., Waterloo, Iowa, succeeding Mr. William B. Addy, resigned.

Mr. J. H. Nuelle, formerly Principal Assistant Engineer of the New York, Ontario & Western Ry., has been promoted to Engineer of Maintenance-of-Way, succeeding Mr. C. E. Knickerbocker, resigned.

Mr. C. E. Knickerbocker, M. Am. Soc. C. E., Chief Engineer of the New York, Ontario & Western Ry., has resigned to take charge of the railway construction work of the MacDonald Construction Co., 149 Broadway, New York City.

Mr. Shirley C. Hulse, Assoc. M. Am. Soc. C. E., formerly Field Engineer of the Second Clackamas Development, Cazadero, Ore., has accepted a position under Mr. W. B. Fuller, M. Am. Soc. C. E., with the Mexican Northern Power Co., Ltd., Santa Rosalia, Chihuahua, Mex.

Mr. Maurice Deutsch, formerly of the firm of Opdycke & Deutsch, of 50 Church St., New York City, has opened offices at the same address for the private practice of civil engineering, specializing in hydraulics and in the design and construction of foundations. The firm of Opdycke & Deutsch has been dissolved.

Mr. H. D. McGlashan, Assoc. M. Am. Soc. C. E., has been appointed District Engineer of the California district of the water resources branch of the U. S. Geological Survey, succeeding the late W. B. Clapp. Mr. McGlashan had been Mr. Clapp's principal assistant during the past two years, previous to which time he was with the Geological Survey in Washington and Oregon.

Mr. Austin B. Fletcher, M. Am. Soc. C. E., State Highway Engineer of California, has announced the following appointments as Division Engineers in charge preliminary surveys and construction: Mr. W. C. Howe, Assoc. M. Am. Soc. C. E., Sacramento, division No. 3.; Mr. F. C. Sumner, Willits, division No. 1; Mr. T. A. Bedford, M. Am. Soc. C. E., Redding, division No. 2; Mr. A. E. Loder, San Francisco, division No. 4; Mr. W. S. Caruthers, San Luis Obispo, division No. 5; Mr. J. B. Woodson, Fresno, division No. 6; Mr. W. L. Clark, Los Angeles, division No. 7.

## Obituary

Harry D. Franklin, an engineer in the employ of the sewer department of Newark, N. J., for 21 years, died on Jan. 9 from pneumonia.

Bernard W. Murray, many years ago a superintendent of construction on the Atchison, Topeka & Santa Fé Ry., and a constructing engineer in the building of a number of government army posts in the West, died, in Seattle, Wash., on Jan. 2, aged 69 years.

Franklin Farrel, Sr., President of the Farrel Foundry & Machine Co., of Ansonia, Conn., died at his home in that city, on Jan. 10, from acute indigestion. Mr. Farrel was 84 years old, and founder of one of the largest foundry and machine companies in Connecticut. He leaves a widow, a son and four daughters.

Henry Fiddeman Lofland, General Manager of Erection of the American Bridge Co., died at his home in Milford, Del., on Jan. 14, from tuberculosis. He was 47 years of age. He was a graduate in civil engineering of the University of Virginia. At the time the American Bridge Co. was organized Mr. Lofland was Superintendent of Erection of the Edgemoor Bridge Works; he was then made Assistant Manager of Erection of the American Bridge Co., having charge of a division. Upon the resignation of Mr. S. P. Mitchell, of Philadelphia, Penn., Mr. Lofland was appointed General Manager of Erection.

George H. White, M. Am. Soc. C. E., Assistant Engineer of the Chicago, Milwaukee & St. Paul Ry., and formerly Professor of Civil Engineering at the Worcester Polytechnic Institute, died at his home, in Minneapolis, Minn., on Dec. 29, aged 60 years. Mr. White graduated from the Worcester Polytechnic Institute in 1876 and was with the engineering department of the Chicago, Milwaukee & St. Paul Ry., from 1878 to 1884, when he went to Worcester, Mass., as Professor of Civil Engineering, which position he resigned in 1901. In 1906 he returned to the Chicago, Milwaukee & St. Paul Ry. as Assistant Engineer. He is survived by a widow, three sons and three daughters.

Sir James Charles Inglis, Past-President of the Institution of Civil Engineres and General Manager and Consulting Engineer of the Great Western Ry. of Great Britain, died on Dec. 19, 1911. He was born in Aberdeen, Scotland, in 1851. His education was received at the Grammar School and University of his native city. He did not, however, finish his college course, but, at the age of 19 years, entered the shops of Norman Copeland & Co., millwrights, or Glasgow, where he remained two years. His next work was with Mr. James Abernethy, whose business consisted largely in the design and construction of harbors and docks. In 1878 he accepted a position with the engineering staff of the Great Western Ry. A short time later he engaged in consulting work on his own account, chiefly in railway and harbor construction. In 1892 he returned to the Great Western Ry. as Assistant Engineer at Paddington. He retained his connection with this railway to the end of his life, and was for 11 years its Chief Engineer. Great improvements took place during this period which placed the Great Western among the most progressive railways of England, and its Chief Engineer, and later General Manager, among the most eminent engineers of that country. He was President of the Institution of Civil Engineers in 1908 and 1909, and early in 1911 was knighted in honor of his distinguished services.

Charles H. Ott, Assistant Engineer in charge of sewer construction, Bureau of Surveys, Philadelphia, Penn., committed suicide by shooting himself, near Wayne Junction Station on the Philadelphia & Reading Ry., on Jan. 4. Mr. Ott was 53 years old and lived in Germantown with a wife and 12-year old son. The reason for his deed is believed by his friends to have been worry and illness caused by overwork. Mr. George S. Webster, M. Am. Soc. C. E., Chief Engineer of the Bureau of Surveys, pays his late assistant the following tribute:

Mr. Ott has been connected with the Bureau of Surveys in various capacities since 1888. In 1895 he had charge of the surveys for the sewers built in connection with the Pennsylvania Avenue subway. He was then appointed Assistant Engineer in charge of the dredging operations carried on by the city in the Delaware River between Philadelphia and Marcus Hook, the work of removing the rock at Schooner Ledge, to a depth of 26 ft., being successfully carried out under his supervision. The channel of the Schuylkill River was also dredged from its mouth to Gray's Ferry Bridge under his direction. On Feb. 1, 1900, he was appointed assistant engineer in charge of sewer construction in the Bureau of Surveys, which position he has filled to the present time in a satisfactory and efficient manner, his long training making him especially valuable in this work.

He was a very conscientious and sensitive man, and keenly felt the responsibility which rested upon him. He devoted his entire time to the duties of his office, starting out early in the morning to visit work of construction and reporting to the office about noon, where the balance of the day was devoted to office duties, frequently causing him to remain until late into the night. He was very careful to carry out every detail of the work under his charge and no doubt brought on a nervous breakdown by too close application to duty.

## Engineering Societies

COMING MEETINGS

SOCIETY OF AUTOMOBILE ENGINEERS.
Jan. 18-20. Annual meeting at New York City. Secy., Coker F. Clarkson, 1451 Broadway, New York City.

KANSAS ENGINEERING SOCIETY.
Jan. 23-24. Annual meeting at Manhattan, Kan. Secy., W. S. Gearhart, Manhattan, Kan.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.
Jan. 23-25. Annual meeting at New York City. Secy., W. W. Macon, 29 West 39th St., New York City.

OHIO ENGINEERING SOCIETY.
Jan. 24-26. Annual meeting at Cleveland, Ohio. Secy., Clyde J. Knisely, New Philadelphia, Ohio.

CANADIAN SOCIETY OF CIVIL ENGINEERS.
Jan. 24-26. Annual meeting at Montreal, Que. Secy., C. H. McLeod, 413 Dorchester St., West Montreal, Que.

INDIANA ENGINEERING SOCIETY.
Jan. 25-27. Annual meeting at Indianapolis, Ind. Secy., Charles Brossman, Union Trust Bldg., Indianapolis, Ind.

CONNECTICUT SOCIETY OF CIVIL ENGINEERS.
Feb. 13-14. Annual meeting at New Haven, Conn. Secy., J. Frederick Jackson, Box 1304, New Haven, Conn.

NEW ENGLAND ASSOCIATION OF GAS ENGINEERS.
Feb. 14-15. Annual meeting at Boston, Mass. Secy., N. W. Gifford, 26 Central Square, East Boston, Mass.

ENGINEERING SOCIETY OF WISCONSIN.
Feb. 14-16. Annual meeting at Madison, Wis. Secy., J. C. White, 624 E. Main St., Madison, Wis.

IOWA ENGINEERING SOCIETY.
Feb. 21-23. Annual meeting at Davenport, Iowa. Secy., S. M. Woodward, Iowa City, Iowa.

### Western Society of Engineers

The annual meeting and dinner were held at the University Club Building, Chicago, on Jan. 10.

The report of the secretary showed a membership of 1139, as against 1119 at the beginning last year. The new constitution, which went into effect with 1911, established a grade of membership (student members) for students at evening schools, and there are now a few members in this grade. The attendance at the meeting has been somewhat small, averaging only 75, even when including an attendance of 450 at the special Steinmetz meeting of the electrical section. The library of the society is not kept exclusively for the use of the members, but is open to the public as a free public reference library. The report of the treasurer showed the following: receipts (including $860 balance of 1911), $19,602; expenditures, $17,844; balance, $1758.

The officers for 1912 are as follows: President, W. C. Armstrong (Engineer of Bridges, C. & N. W. Ry.); vice-presidents, A. Bement, G. T. Seely and E. C. Shankland; treasurer, A. Reichmann; secretary, J. H. Warder.

### American Institute of Electrical Engineers

At the 297th meeting in New York City, Jan. 12, Mr. P. R. Moses presented a paper entitled "Notes on Isolated Plants." He presented figures which he had collected to show that the importance of isolated stations had been greatly underestimated. The specific figures given in the paper related to conditions in New York City. For instance, he stated that there were 1700 isolated plants in the city, having an aggregate boiler capacity of 929,000 hp. and an aggregate engine capacity of 669,855 hp. The total boiler horsepower of the central stations in New York City he did not quote, but contented himself with showing that the largest stations had a capacity of 109,000 hp.

In discussing the influence of services about a building, other than lighting, on isolated-plant equipment, he advocated using high-efficiency apparatus with electric drive for the auxiliary machinery where the steam required for heating, etc., is less than would be supplied by the usual electric plant alone. He advocated an electric plant of moderate efficiency together with steam-operated auxiliaries where the steam required for heating, etc., was more than that yielded by the electric plant for usual services alone. The author cited several instances showing the service loads in buildings of different types in New York City.

The discussion was generally critical, some claiming that the data were not complete and not properly identified. There was a general call for data on the investment and overhead charges of the different isolated plants mentioned. Mr. Arthur William, of the New York Edison Co., stated that in Manhattan only there were 691 private plants, having a total of 295,685 boiler horsepower and 211,096 hp. in engines driving electric generators, instead of the figures given by Mr. Moses. He claimed 300,000 hp. of central-station boilers in the borough. He claimed that the 211,096 hp. of the private plants has only 150,000 hp. connected loads, while the 300,000 of the central station has 500,000 connected load. The isolated-plant designer had to provide a large excess capacity, while this sort of reserve in the case of the central station could be made negative, as shown, on the account of the improbability of excessive demand from many consumers simultaneously.

### New England Water Works Association

The annual meeting of the Association was held in Boston, on Jan. 10. After the usual lunch at one o'clock, the business exercises were taken up. These consisted in the reports of the officers of the Association for the year, presentation of various committee reports and the address of the retiring President, together with the reports of the tellers on the annual election of officers. An address was delivered by J. Waldo Smith, chief engineer of the Board of Water Supply, New York. The report of the Secretary, Mr. Willard Kent, showed a total membership, on Dec. 31, 1911, of 750, which was a net gain of three for the year.

Reports of progress were made by the Committee on Conservation, M. N. Baker, chairman; the Committee on Water Consumption and Statistics relating thereto, Leonard Metcalf, chairman, and the Committee on the Collection of Information as to low water yields of drainage areas in New England, F. P. Stearns, chairman. Mr. Metcalf reported in behalf of his committee disappointing returns from those who had been asked to give information on water consumption, and stated that the committee had concluded that it would be advisable to make a study of the detailed records of a few water-works plants, keeping records worth while, rather than to attempt an extensive study as proposed. He also stated that during a recent trip abroad he had made an inquiry regarding water consumption. He was surprised to find that while detailed records were available as to the amount of water used for public purposes no information could be obtained as to the division of water between various classes of private consumers.

The Committee on Standard Specifications for Fire Hydrants submitted a final report in printed form, which had already been circulated among the members of the association. A motion for the adoption of the report led to a considerable discussion as to the advisability of giving the associate members of the association, interested in hydrant manufacture, more opportunity to be heard. The members of the committee seemed to feel that the manufacturers had not taken full advantage of the opportunities for conference and for hydrant tests offered them. Representatives of the manufacturers urged that they never had any real standing with the Committee and, therefore, had not felt like asking much in the way of cooperation. It was finally voted to ask such of the associate members as are interested in the manufacture of fire hydrants to confer with the committee, and it was also voted to ask the committee to report again at a later date. It should be added that H. O. Lacount, of Boston, is chairman of the committee in question, and that the names and addresses of the other members of the committee were given on page 70 of our issue of Jan. 11, 1912.

Mr. J. Waldo Smith, whose name has already been mentioned, gave an extempore account of the exploratory and construction work on the Hudson River crossing of the Catskill Aqueduct for the New York water supply. This work has been described in a number of articles which have appeared in our columns. Mr. Smith stated that the tunnel headings are now within some 200 ft. of each other, and it is expected that they will meet within a comparatively short time. He also said that only 36 gal. of water per minute is being encountered at one of the headings and 150 gal. at the other. The flow of water from a seam penetrated some time ago was finally controlled by the use of grouting under a pressure of 1000 lb. per sq.in., which Mr. Smith thought was the highest pressure for this class of work on record.

The major part of the presidential address, delivered by Allen Hazen, was devoted to the subject "Management of Water-Works," and is printed separately elsewhere in this issue. Before taking up this part of his address, Mr. Hazen paid tribute to the ten members of the association who had died in 1911. These included such well known men as G. A. Hague, civil engineer, of New York City; L. E. Halls, civil engineer, of Boston; L. C. Kinnicutt, professor of chemistry, of the Worcester Polytechnic Institute, Worcester, Mass., long known for his work in connection with sewage treatment, and C. W. Paine and W. H. Spears, both civil engineers, the first of Highland, Calif., and second of Plymouth, Mass.

Other parts of Mr. Hazen's address dealt with available water supplies in dry years, with particular reference to the recent unusually dry spell. In order to give this section of the address due prominence, it will be printed separately in a later issue. The tellers selected announced that George W. Batchelder, of Worcester, Mass., had been elected as president of the association, and George A. King, of Taunton, Mass., as advertising agent; and that the following officers had been reëlected: Secretary, Willard Kent, Narragansett Pier, R. I.; Treasurer, L. M. Bancroft, Reading, Mass.; editor of the "Journal," Richard K. Hale, Boston, Mass.

# Engineering Literature

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## EDITORIAL

### Changes in the Engineering Literature Section of Engineering News

A little over nine years ago (Dec. 18, 1902), this journal began the systematic publication of reviews and announcements of technical books, reports and pamphlets, accompanied, as occasion offered, by editorial discussions and by correspondence on related topics. Prior to that time such book reviews as appeared in our columns were generally brief and were inserted at chance intervals. Under the new plan, once in each month there have been added to the body of our regular issue, a goodly number of pages devoted to Engineering Literature.

Originally, Engineering Literature was a Supplement in fact, as it has always been in name. Through most of its history it has been paged separately, on the theory that many subscribers would find it more convenient to bind the Supplement consecutively at the back of each volume, while perhaps a few would not wish to bind it at all, and would, therefore, be inconvenienced by a continuous pagination.

Partly because Engineering Literature was regarded as a Supplement—almost a complete paper in itself—and partly because at the outset financial assistance was desired to help meet the increased cost of devoting so much space to technical literature, advertisements were admitted to Engineering Literature at its inception. They have appeared ever since.

To speak frankly, the editors never liked the idea and have always been aware that many subscribers did not like the idea, of publishing book advertisements with book reviews, even though the advertisements were kept in the background and Engineering Literature was a Supplement. We therefore take pleasure in announcing, and we are confident that our subscribers will be pleased to read, that hereafter no advertisements will be included in the section of this journal devoted to Engineering Literature.

It is only fair to the book publishers who have so generously supported Engineering Literature from its inception to state plainly, as we have already intimated, that it has been largely through their financial assistance and particularly through their kindly words of appreciation of our efforts that we have been encouraged to develop Engineering Literature as it has been developed during the past nine years. At the same time we do not feel that the transposition of book advertisements from the old-time Supplement to a place in our regular advertising pages is an act of base ingratitude to the advertisers who served, in a way, as godfather to Engineering Literature and who stood by it in its infancy and early youth. The change which is being made is prompted by a desire to give better service to our readers and thus to all our patrons.

Another reason for removing advertisements from Engineering Literature is that it long since ceased to be a Supplement, while hereafter it is to be even more an integral part of ENGINEERING NEWS than it has been in the past. Since hereafter this department may sometimes be inserted in advance of the editorial pages, the continuance of advertisements among book reviews has become as impossible as would be placing them on our editorial pages.

As may be inferred from some of the foregoing remarks, the word Supplement will no longer be coupled with this section of ENGINEERING NEWS.

Since we have referred to the inception of Engineering Literature, it may not be amiss to say that the plan, scope and ideals set forth in the initial number (Dec. 17, 1902) are to be followed in the future as in the past. Briefly summarized, our aim has been and is "to convey prompt and critical information" regarding the more permanent literature of "the several branches of engineering, and the various arts and sciences related thereto," at the same time covering "such phases of economics, sociology, municipal administration, public art, exploration, travel, biography and history as appeal particularly to the readers of ENGINEERING NEWS."

It should perhaps be stated that what we believe has contributed as much as, if not more than, anything to the success of Engineering Literature has been its appeal to members of the engineering and allied technical professions for assistance in valuing books, and the hearty response with which that appeal has been met. Nothing of this was suggested in the first issue of Engineering Literature, neither in the editorial announcement which we now reprint nor in the reviews which appeared in that number.

In fact, all the reviews in the first few issues were written by members of our editorial staff, exactly as had been true of the book reviews which appeared in this journal before Engineering Literature was started. But it soon became a physical impossibility for the members of the editorial staff to write so many and such extensive reviews as seemed to be due to our readers, even had the editors been vain enough to consider themselves specialists on so many and such diverse subjects. Accordingly, first a few, then a considerable number, and latterly many books were sent to engineering and other specialists, until now the list of outside reviewers numbers several score.

In two respects our hopes, as announced nine years ago, have not been fully realized: (1) Most of the letters sent for our Correspondence column have been from authors who thought justice had not been done to their books by reviewers (but the number of these letters has really been surprisingly small), whereas we had hoped that many of the formal reviews would bring in a greater number of supplementary criticisms from readers than have been received, and (2) we have published fewer general reviews of all or the best books on selected topics than we had hoped to do. In our earlier issues, we passed in general review books on cement and other important subjects. That sort of reviewing seemed to have rather sharp limits for the editorial staff, partly through pressure of other work. A few outsiders have voluntarily submitted valuable general reviews of groups

of books and we should be pleased and we are sure our readers would be glad to have the practice continued and extended.

In conclusion, we repeat in substance and renew without change or reservation the words with which we closed our announcement nine years ago:

We hope that with the coöperation of our readers and of both authors and publishers, we may eventually do for engineering and other technical books what the best of the literary weeklies and monthlies are doing so well for general literature, and that thus we may contribute somewhat to the advance of engineering and the allied arts and sciences, and to the sound development of their literature.

# CORRESPONDENCE

## From the Author of "Experimental Engineering"

Sir—I am in receipt of a copy of ENGINEERING NEWS for Dec. 14, 1911, containing the very appreciative review by Nicholas S. Hill, Jr., of my book on "Experimental Engineering." If practicable, I would have been glad to embody in the book the various things which the reviewer finds lacking, but the book was written primarily for the naval engineer, and with a particular view to meeting the requirements of the Naval Academy for a textbook. A good deal of more or less obsolete apparatus is retained in the book for the reason that it is used by the students in the engineering laboratory at the Naval Academy. As the reviewer very justly states, however, it may be considered as illustrating the principles involved.

U. T. HOLMES,
Commander, U. S. N.
U. S. S. "Louisiana," Dec. 23, 1911.

## An Appreciation of Greene's "Pumping Machinery"

Sir—I have read with much interest Mr. Nicholas Hill's review of Prof. Greene's book on pumping machinery, which appeared in your Supplement of Oct. 12, and believe that Mr. Hill has rather underestimated the value of this work.

The book seems to fill very admirably the need which existed, for an uptodate, comprehensive work on pumping machinery.

It is pleasing to find a book labeled "Pumping Machinery," which treats of pumping machinery in all types, and is not burdened with extraneous matter concerning boilers, etc., which properly belongs elsewhere. The book also includes an interesting chapter on the design of centrifugal pumps which, in their modern forms, are of great importance.

The very clear manner in which Prof. Greene has handled the various subjects, both on their analytical and practical side, will make the book of service to students as well as to those who, like the writer, have had to do with the design, construction, operation and testing of large pumping plants. [Mr. Head was formerly mechanical engineer of the Bureau of Water, Philadelphia.—ED.]

FRANCIS HEAD,
Sao Paulo, Brazil, Nov. 26, 1911.

## On the Review of "Walls, Bins and Grain Elevators"

Sir—In the review of the first edition of the writer's "The Design of Walls, Bins and Grain Elevators" in your issue of July 18, 1907, and again in the review of the second edition, in your issue of Dec. 18, 1911, the reviewer has entirely failed to get the idea of the book, but has devoted the greater part of both reviews to Part I, the Design of Retaining Walls, and to the design of reinforced concrete, both of which are introductory to the main discussion; and he has not considered the main part of the book as given in Parts II and III.

Quoting from the preface to the first edition: "The aim in writing this book has been to present a systematic analysis of the stresses due to granular materials, together with a discussion of the principles of design and the details of the structures which contain the granular materials." Experiments to determine the pressure of granular materials on retaining walls and in shallow and deep bins are given and discussed, and methods of calculating the stresses are given.

In the second edition the chapters covering the design of retaining walls have been rewritten to accord with modern practice, and two additional chapters have been added. In Chapter IA it is shown that when active stresses and passive resistances are distinguished between and made to agree with the known laws of semi-fluids, the "Theory of Conjugate Pressures" gives consistent results. In Chapter IVA are calculated the stresses in bracing of trenches, pressures on tunnels, sewers and temporary retaining walls. The discussion of reinforced concrete is merely incidental, and in it standard practice has been followed.

In both reviews the reviewer criticizes the book: (1) As having too much theory, and (2) he takes exception to the discussion on reinforced-concrete construction; on both of which subjects the views of the reviewer are not in accord with most writers. A third criticism of the first edition was in the use, by the author, of a simple formula involving hyperbolic logarithms, in place of complicated formula transposed to use Briggs' logarithms, as suggested by the reviewer.

In criticizing the theoretical investigations in the book the reviewer frankly refrains from expressing any opinion upon the discussion of the pressure of grain in bins and the laws of semi-fluids, the most important part of the book.

It is, of course, evident that to make the book conform to the reviewer's suggestions in his review of the first edition, would have made it necessary to practically eliminate all theoretical discussion of the pressures of semi-fluids, and to have made it merely a book of examples of structures. In view of the above the last paragraph of the review of the second edition—"Lack of space prohibits the reviewer from repeating the criticism of his first review. They all apply to this edition, for they have been uniformly ignored"—is a rare bit of humor.

MILO S. KETCHUM.
Boulder, Colo., Jan. 4, 1912.

# REVIEWS

## Statically Indeterminate Reactions and Stresses

REVIEWED BY HENRY S. JACOBY*

DEFLECTIONS AND STATICALLY INDETERMINATE STRESSES — By Clarence W. Hudson, M. Am. Soc. C. E.; Professor of Civil Engineering, Polytechnic Institute of Brooklyn, N. Y.; Consulting Engineer, New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 7¾x11¼ in.; pp. 258; folding and other plates and many text illustrations. $3.50 net (15s. net).

Professor Hudson has had so many years of experience in practice as a bridge engineer and is so well known as an expert computer, that the announcement of this book was read with keen anticipation. It is a pleasure to state at the outset that after a careful examination of the volume the anticipation appears to have been well warranted.

The aim of the author, as stated in his preface, is to give the few principles which underlie the subject of statically indeterminate reactions and stresses, and to show their application to a number of practical problems. He recognizes fully that the solution of numerical problems is essential not only to a working knowledge of formulas and methods, but also to a thorough comprehension of the principles themselves and of the conditions which limit their application.

A number of fundamental formulas for deflections are deduced by means of the equation of the elastic line of a straight or curved beam; by the internal work of flexure with the aid of an auxiliary load of unity; and by the work of deformation due to shear. The first and second theorems of Castigliano, and Maxwell's reciprocal theorem relating to deflections, are likewise deduced.

Formulas are derived for the deflections of cantilever, simple and continuous beams of constant cross-section under different conditions of loading, like those usually given in works on mechanics. Six similar formulas are then deduced for practical cases in which the

*Professor of Bridge Engineering, College of Civil Engineering, Cornell University, Ithaca, N. Y.

moments of inertia of cross-sections are variable, and some of them are used to find the reactions for plate-girder swing bridges.

The solution of two numerical examples with spans of 136 and 156 ft., one a very light single-track, and the other a heavy double-track plate-girder swing bridge, shows that the reaction of the center support is respectively 15 and 11% greater by the more exact method of computation than by assuming the moment of inertia to be constant. It is also found that in the first example the deflection of the end of the span due to the shearing stresses is about 4 and 3% of that due to the flexural stresses alone, for uniform load and for a concentrated load at the free end, respectively. The bending moment at the center support is reduced about 2.6% when the effect of shearing stresses is included. For the longer and heavier swing span the corresponding results are about twice as great.

The publication of such numerical results for representative examples cannot fail to be appreciated by engineers in practice, since they wish to know to what extent increased refinement in computations is justified by its practical effect on design.

An example is given to show the high degree of accuracy obtained in computing deflections by approximate methods of integration which have to be employed when the curve of the elastic line cannot be expressed by an equation.

In a number of cases the same problem is solved by different methods, thus exhibiting very effectively their relative merits when used in practice. For example, in finding the end deflection of a plate-girder swing bridge when open, the use of Fraenkel's formula involving bending moments due to an auxiliary unit load, only about one-tenth of the labor is required as by the method which is based on the equation of the elastic line.

The application of this simple method is illustrated by finding the deflections and stresses in a circular ring under a single load, in a pipe culvert, and in the steel frame of a tunnel lining. In each case there are given the device of cutting the section for the application of the auxiliary loads, the statement of equations to meet the conditions imposed by the problem, and the complete solution of a numerical example.

The same method is also used in making the computations of the maximum and minimum stresses for the complete design and erection of a concrete arch having an effective span of 100 ft. and with spandrel arches supporting the roadway. The arch rib is cut at the crown and formulas are derived for the unknown horizontal thrust, shear, and bending moment at the crown due to any single concentrated load, temperature change, or rib shortening. The numerical work is systematically arranged in tabular form to facilitate the labor of computation. It is gratifying to note that every step in the different operations is illustrated fully and that the forms adopted indicate the judgment and care of a master in this art. Several features deserve especial mention. The loading for the greatest compression or tension in any section is found graphically by means of the lines of action of the inclined reactions for each concentrated load and of the two curves in the arch rib which give the limiting positions of the resultant thrust for tension or compression in any cross-section. The most unique part of these computations relates to the erection, the results of which determine in what order the cross walls, spandrel arches, etc., are to be erected after the main falsework has been lowered and the arch rib is self-supporting.

Similar calculations of maximum and minimum stresses are given for the design of a two-hinged arch rib with solid web plate, the span being 144 ft. long.

The detailed computations of the deflection of a simple truss under given dead and live loading are made with the aid of Castigliano's first theorem, by least work, and by displacement diagrams, thus showing by inspection the relative merits of these methods. Another numerical example gives the additional effect upon deflections of play of pin holes in a truss, and then the computations are completed for the camber blocking and the exact manufactured lengths of the truss members to secure strict compliance with given conditions.

A further comparison is given between the analytic and graphic methods when applied to a cantilever bridge, while another example indicates what procedure is required when the deformations are so large that the deformed truss is no longer closely similar to its normal shape.

Another comparison between two methods of computing the stresses in a simple truss with redundant members proves the method of distortion due to unit loads acting in the redundant members to be more serviceable than the one based on Castigliano's second theorem.

Formulas are derived to determine the stresses in partially continuous trusses like those of the Queensboro cantilever bridge at Blackwell's Island, for double-leaf bascule bridges, and for open-webbed arches without hinges; but in these cases numerical examples are omitted.

The remaining solutions of numerical examples include the computations for the true reactions of center-bearing and rim-bearing swing bridges; of the stresses in a small suspension bridge with eye-bar cables and a stiffening truss hinged at the towers; of the stresses in a viaduct bent with double intersection bracing; and of the stresses in spandrel-braced arches having three and two hinges, respectively.

Two methods are employed to find the stresses in the two-hinged arch. In the first method, the arch with three hinges is transformed into one with two hinges by inserting an additional chord member near the crown, and the additional stresses in all members are computed with the aid of deflections and stresses due to auxiliary unit loads applied to this extra chord member when cut apart. This method is claimed to be highly advantageous and at the same time affords a direct comparison between all the corresponding stresses of the two types of arches.

The second method is the customary one in which certain elastic deformations and deflections are found due to a horizontal load of unity applied at one hinge, which is assumed to be supported on rollers like the expansion end of a simple truss. The arrangement of the tables in both cases and various other suggestions by the author will repay careful study.

One chapter is devoted to mechanical adjusting devices and the necessary adjustments required to make the final closure in the erection of important structures. These structures consist of the cantilever bridge over the Arroya Del Chico in Mexico, that over the Monongahela River at Pittsburg, and those over the Ohio River at Beaver and at Sewickly, Penn.; the Niagara and Clifton arch; and the Benwood bridge over the Ohio River, in which simple trusses were erected by the cantilever method. The details of toggles, wedges and other devices, as well as members to which they are attached, are illustrated by cuts in the text and on folding plates.

Since the practice is now nearly uniform in American text-books to designate tension by plus and compression by minus, it is to be regretted that the author reverses this convention. The text contains so many features which are praiseworthy that they overshadow the minor defects. It should be noted that a knowledge of mechanics and of bridge stresses in statically determinate structures is assumed throughout. Some methods of treatment and formulas, including those for the arch without hinges, are original.

To many practicing engineers, and perhaps to the majority, the methods employed for statically indeterminate structures seem complicated and difficult to apply, and some are discouraged in their study of the subject by the fragmentary manner in which the methods are often exemplified. To such practicians, as well as to advanced students, this book can be warmly commended as very helpful, and it may properly be regarded as a valuable supplement to all of the works dealing with the same general subject which have been published. It ought to be added to the working library of every bridge and structural engineer.

## Experiments and Tests

Reviewed by HARRY L. PARR*

THE TESTING OF MOTIVE-POWER ENGINES—Including Steam Engines and Turbines, Locomotives, Boilers, Condensers, Internal Combustion Engines, Gas Producers, Refrigerators, Air Compressors, Fans, Pumps, etc. By R. Royds, M. Sc., A. M. I. Mech. E.; Lecturer in Motive-Power Engineering, Glasgow and West of Scotland Technical College, London, New York, Bombay and Calcutta: Longmans, Green & Co. Cloth; 6x9 in.; pp. 396; 83 text illustrations. $3, net.

During the past few years the importance of accurate experimental work in the engineering field has become more and more apparent. Whereas formerly this sort of work was practically limited to determining the efficiencies of such standard machinery as boilers, engines and pumps, and how such efficiencies were affected by a change in such variable factors as load, speed, fuel and pumping head, its scope has now been vastly broadened and includes among other important subjects investigations for determining the constants which must be applied to the formulas of mechanics, thermodynamics and hydraulics to allow for influences that cannot be formulated when these formulas are to be used in designing an actual machine. Experimental mechanical engineering has consequently become such a broad subject that it may almost be classed as a profession by itself, and the great variety of instruments and methods which have been designed for the measurement of different quantities have made it impossible for an engineer engaged in any other class of work to keep in touch with the subject and, therefore, none but the simplest tests can be intelligently laid out without some sort of advice from an expert as to the best methods to employ. In nearly all engineering schools the students are being trained in the elements of experimental work, and books by authorities on the subject are needed for reference and study.

Experimental work may be roughly divided into two classes: (1) Those tests of standard apparatus which permit of being codified and whose object is to determine such characteristics of performance as may be necessary in establishing guarantees; (2) all forms of investigation not following codified procedure. To the former belong such tests as the determination of the capacity and efficiency of a boiler, or the duty trial of a pumping engine; to the latter belong such investigations as the effect of varying the velocity of water passing through condenser tubes upon the rate of heat transfer, the variation of the angular velocity of the shaft of a hit-and-miss governed gas engine, the relation between the actual performance of an impulse steam turbine and that computed from hypothesis.

A book on experimental mechanical engineering may, therefore, have two objective and two subjective aims. It may be intended to serve as a textbook for students or as a reference book for engineers, and it may treat of the conducting of standard tests or of what may be termed research methods. There appears to be no reason why a difference should be made in the method of presenting the subject matter, whether the book be intended primarily for students or for engineers unless the engineer is credited with a clear understanding of the principles involved, which it is not always safe to assume in connection with this particular subject; nor does it appear that one sort of experimental work can be adequately treated to the exclusion of the rest. It, therefore, seems to the reviewer that all of the aims mentioned may be realized in a single book and that any book on experimental engineering not specifically confined to a single phase of the subject should be judged on this basis.

The title of Mr. Royds' book, "The Testing of Motive Power Engines," would indicate that it covered only a small portion of the general field of experimental work, but as a matter of fact it touches on nearly all phases of it. The author states in the preface that his book "is intended for engineering students who have already acquired an elementary knowledge of motive-power engineering" (whatever that may mean) and hopes that it will be of service to the engineer in practice. The introduction contains some excellent general suggestions concerning the laying out of tests and urges the necessity of planning all experimental work as part of some definite scheme; the forms of errors which may occur in observations are also discussed, with suggestions as to how such errors may be reduced to a minimum. In the first chapter are given definitions of work, power, temperature and heat, together with a brief explanation of the principal heat cycles on the pressure-volume and temperature-entropy bases, and directions for calculating indicated horsepower from indicator cards, brake horsepower, thermal efficiency, etc. The author notes that this information is intended to serve as a convenient source of reference, presumably for those who have studied mechanics and thermodynamics, but have forgotten the details.

Chapters I and II describe the principal instruments and methods for measuring pressure, temperature and brake horsepower. For each instrument described careful note is made of its range of usefulness, sources of error and method of calibration.

The remainder of the book is devoted to the testing of locomotives and motor cars, steam engines and steam turbines, boilers, condensers and air pumps; internal-combustion engines, gas producers, refrigerating machines, air compressors and air motors, fans and blowers and water turbines and pumps in the order given.

In taking up each subject the author states the principal independent variable conditions affecting the operation and later in the chapter gives curves showing the results of actual tests run to determine the effect of independently varying these conditions. Considerable space is devoted to discussion of results which have been obtained by other investigations. The method of presenting the subject matter describing the actual conduct of such tests suggests by its order of presentation that the book is primarily intended for the use of students in pursuing a definite course in experimental work which will closely follow the book, but the character of the subject matter itself seems to assume a familiarity with actual conditions of operation which would be unfair to expect of the ordinary student in an engineering course.

With the exception of the methods of measurement described in Chapters I and II, all descriptions of the measurement of quantities are taken up as needed in carrying out the tests described. This method may appear to be the most logical from the teaching standpoint, but makes the book of doubtful value to the engineer who is laying out some test not described in the book and who wishes information concerning the various methods available for measuring certain quantities. For instance, the information concerning gas analysis and combustion is distributed between boiler trials and tests of internal-combustion engines; the quantitative measurement of liquids is distributed between boiler trials, tests of condensers, internal-combustion engines and pumps; the quantitative measurement of gases is distributed between condensers, internal-combustion engines and fans and blowers. This objection is partially offset by a good index, but while the methods of measurement are ably described and in several cases new and ingenious, there is much valuable matter omitted which must almost inevitably be the case when subjects are treated in a disjointed manner and are taken up merely to fill some particular need. This plan of giving detailed descriptions of methods of measurement as part of the discussion of tests of machines draws the attention from the main subject, which is the laying out of a test to secure some definite information. No general method is developed for the attack and solution of experimental problems, although such a method is followed by the author in his descriptions of tests.

This book may be found valuable as a textbook to be used in connection with courses on experimental engineering, providing the instructor in charge of such a course is willing to follow the text rather closely. For American engineers

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it will not be as useful as several other books which have been published in this country, not only on account of the reasons already given, but also because of the fact that the standard test codes referred to are those of Great Britain, which are somewhat different from those accepted in this country. However, as a book to be read in connection with experimental work, much valuable information may be obtained from it.

## A German Study of Power Production

Reviewed by LIONEL S. MARKS*

NEUERE KRAFTANLAGEN—Eine technische und wirtschaftliche Studie auf Veranlassung der Jagorstiftung der Stadt Berlin unter Mitwirkung von Dr.-Ing. Gensecke und Dr.-Ing. Hanszel. Bearbeitet von E. Josse, Professor an der Kgl. Techn. Hochschule zu Berlin, Vorsteher des Maschinenbau - Laboratoriums. Zweite, wesentlich vermehrte Auflage. München and Berlin: R. Oldenbourg. Paper; 6½x9¾ in.; pp. 149; 93 text figures. M. 5; American price, $2, net.

Two years ago the present writer prepared for these pages (see June 17, 1909, p. 70) a review of the first edition of Professor Josse's interesting and valuable contribution to our knowledge of the contemporary state of the art of power production. This study of the technical and commercial aspects of that very important subject was made possible by a grant for a special fund under the control of the City of Berlin. It would appear from the second edition now before us, that the very practical and far-sighted curators of that fund have continued their grant and have made possible the continuance of the excellent work which they originated. For it is surely of much importance in a large industrial community that a technical and commercial study should be made of the methods and costs of the production of power for the guidance of the owners, designers and operating staffs of power plants, and for the benefit of members of the engineering profession.

The new edition is considerably larger than the older and not only extends the information given along the lines already treated of, but also sums up the important new developments of the past two years. Whereas the earlier edition discussed only small- and medium-sized plants, the present work takes up large plants also. The most important changes and additions are in the discussion of the influence of superheating, of steam pressure, and of back pressure in steam engines; of condensation; of single-cylinder steam engines; and of the new methods of regulation of steam turbines. Further additions deal with low-pressure turbines, with large gas engines and with Diesel engine plants.

The peculiar virtue of this work is that its conclusions throughout are based directly upon special investigations of numerous modern plants. These investigations are collected from various sources, but have been in large part carried out specially for this work, or are a portion of the surprisingly large output of Professor Josse's laboratory at Charlottenburg. The result is to present to the technical world something which comes more near to being a summary of the present state of the art of power production than anything else that has been published. Its technical conclusions apply, of course, only to German practice and its commercial conclusions apply only to German conditions, fuel and labor costs, and so forth. Nevertheless, the technical results can be duplicated elsewhere and the commercial results can be modified to allow for other conditions.

Among the recent developments some space is given to the rapidly growing use of coal-tar oil as a fuel for boilers. The Charlottenburg experiments with this fuel, include spraying by pressure alone, by steam, and by compressed air. The use of simple pressure spraying is found to be the most economical except in plants where compressed air is available.

The results of the special investigations at Charlottenburg on the influence of superheat and of vacuum on the efficiency of steam turbines, are presented in a manner which permits an interesting contrast with the possibilities of a perfect machine. It is found that saturated steam must be superheated 17° C. to effect a 1% saving in the heat required per unit of power; the increment of superheat necessary for each additional 1% saving is found to decrease continuously as the superheat increases and reaches a value of 11.5° C. at 184° superheat. These results, obtained on a 200 kw. A. E. G. turbine, with 180 lb. gage pressure, and 95% vacuum, show considerable differences from the values usually accepted.

The tabulation of results of recent tests of reciprocating steam engines brings out some interesting facts. The simple non-condensing engine, in its recent form of "Gleichstrommaschine" of Stumpf, develops as much as 87% of the theoretically possible indicated work of the steam (in a 200 hp. unit); and gives about 80% of it at the shaft. This high degree of perfection of the simple engine leaves little room for improvement by compounding and, in the opinion of the author, the compound engine will begin to disappear from engineering practice. With simple condensing engines, the best recorded performance at the shaft is about 65% of the theoretically possible indicated work on a 200-hp. unit. The best performance by a compound engine in the author's tables is about 75% on a 700-hp. unit. There is, consequently, still some saving possible by compounding, but not very much.

The data on turbines include tests on all the common types and on sizes varying from 50 up to nearly 12,000 useful horsepower. The most perfect performance recorded is the development at the shaft of 73% of the theoretically possible work on a 10,000-hp. unit in the well known Erste-Brunner tests.

It is interesting to see that the Brown-Boveri, Westinghouse, Curtis, Nurnberg, Bergmann and other turbines, will all develop about 70% of the theoretical work for sizes varying from 2000 to about 12,000 hp. Considerable discussion is given to low-pressure turbines and to the economics of turbine installations in which some of the steam is abstracted for outside purposes while it is on its way through the turbine. The equalizing heat-storage devices for low-pressure turbines include some novel constructions. Among other important matters relating to the steam turbine, is the relation of the method of governing to the variation of economy with load; some new tests throw valuable light on this subject.

The data given on gas-producer plants, show a maximum efficiency from coal to engine shaft of about 24%; of the producer alone, 85%; of the engine alone, over 28%. There is not much variation from these figures in recent plants. The Diesel engines show a maximum overall efficiency of about 35%; that is, there is no notable increase in their efficiency. An interesting development is the application of small four-cylinder Diesel engines, from 20 hp. up, to automobiles. Such engines, developing 5 hp. per cylinder and using crude oil, show an overall efficiency of 26% at rated load—a performance which is certainly considerably better than that of any other automobile engine and which, in view of the cheapness and safety of the oil used, may have much meaning for the future development of powered vehicles.

The last third of the book deals with the cost of power. Tables are given of the operating costs of numerous plants with engines of all the various types and sizes. The operating costs for medium-sized steam-engine plants vary from 1.5 to about 3c. per kw.h.; for locomobile plants, from 1.2 to 2.8c.; for small turbine plants, 1.3 to 1.5c.; large steam-engine plants, 0.7 to 1.7c.; large steam-turbine plants, 0.44 to 1.3c.; small producer-gas plants, 1.3 to 2.2c.; large gas plants (blast-furnace gas), 0.2 to 0.3c.; Diesel plants, 0.4 to 2.6c. These figures have, of course, but little meaning apart from a knowledge of the cost of fuel and of labor.

It is a pleasure to read so suggestive and so timely a study of power generators. It would be a useful thing to engineers in this country if the U. S. Bureau of Mines, which has already made a detailed study of the operation of several kinds of power generators, should collect and publish a body of facts such as are presented here.

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# Two Notable Works on Mechanical Flight

LANGLEY MEMOIR ON MECHANICAL FLIGHT—[Vol. 27, No. 3, Smithsonian Contribution to Knowledge.] Part I, 1887-1896. By Samuel Pierpont Langeley. Edited by Charles M. Manly. Part II, 1897-1903. By Charles Manly, Assistant in Charge of Experiments. Washington, D. C.: The Smithsonian Institution (Charles D. Walcott, Secy.) Paper; 10x13 in.; pp. 320; 101 plates.

AERIAL NAVIGATION—A Popular Treatise on the Growth of Air Craft and on Aëronautical Meteorology. By Albert Francis Zahm, A. M., M. E., Ph. D., Secretary of the Aëro Club of Washington; Governor of the Aëro Club of America, etc. New York and London: D. Appleton & Co. Cloth; 5¼x8¼ in.; pp. 497; 32 plates; 58 illustrations in text. $3, net.

It is a positive pleasure to pick two volumes of such conspicuous merit and intrinsic interest out of the many mediocre books and works on aerial flights. The Langley Memoir has, moreover, no small historical value as the detailed record of probably the most brilliant and most scientific attack of the problem of aerial flight that has been made. It is clearly evident to any one who has followed the independent development of the "aeroplane" that the newspapers of the country, by their hostile criticisms of Prof. Langley's work, did truly turn back the hands on the clock of progress a few years. The barriers that held the Langley "aerodrome" from as complete and unqualified success as the early Wright flyers were so slight that it needed only insignificant efforts to brush them aside. However, the work was being done with public and institutional funds which the criticisms referred to cut off. At the same time, Prof. Langley held such high ideals of service that he would not secure the aid of that commercial exploitation which has carried forward more recent development and undoubtedly would have backed his efforts.

The Langley Memoir is in two parts, the first of which, covering the years 1877-1896, was written by Prof. Langley and completed shortly before his death. The second part, covering the period of 1897-1903, was written by Mr. C. M. Manly, the mechanical engineer in charge of much of the work planned in a general way by Prof. Langley.

Part I. deals with a long series of early experiments with small models. The first of these relied on rubber-band motors, but such a primitive device was soon outgrown and vapor engines had to be developed. Accordingly, the first section of the memoir relates in detail the development of engines, boilers and burners of remarkable lightness and capacity. The object of these model studies seems to have been to show that mechanical flight was possible as a future commercial project and to point the type of mechanism by which success was to be won. It evidently was not Prof. Langley's first intention to build a man-carrying flyer, but he was led into that project by the success of his model experiments. Once embarked on the work, he pursued it with vigor and persistence to his death.

In Section II. Mr. Manly has described the work of designing the man-carrying flyer in the light of the previous studies, the construction of the large-size models and finally the great machine itself. The difficulties that arose are here stated and the way in which they were overcome. Not least among these problems was the development of a suitable engine. Steam had to be abandoned for the then-new gasoline type and the magnitude of the task is seen by comparing the excellent performances described in this memoir with those of modern automobile engines whose development has had the combined wisdom of hundreds of designers for a decade.

The story of the field trials of the final machine is now well known but it is retold here in authoritative detail.

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Prof. Zahm's book is essentially descriptive—he has popularized performance and not theory. Indeed, one will look in vain here for an exposition of the dynamics of aerial flight. This will be generally considered a wise course, considering the number of adequate expositions of theory now printed and remembering the good use which has been made of the five hundred odd pages of this book. A bigger book would have been cumbersome and the excess would have been unnecessary.

It has been noted that the author's presentation is descriptive; it is more than that, for it is at once an analysis of the features of successful flights, and a connected history of movements in this and that direction covering decades often and involving the efforts of men not commonly associated. The narrative has no small literary charm, which seems to lie largely in sustained interest, where others have grown weary and labored, and in a number of passages which are notable examples of imaginative writing. Yet so dignified and controlled are they that the well-versed reader will not experience the repugnance felt toward the work of many previous authors in the same field.

The author has brought to his task of writing this book probably a better preparation than afforded to any other living person. Though his name is borne by no famous monoplane, biplane, glider or dirigible balloon, yet he has aided and abetted in many an invention that has made some small advance at least. His theoretical and experimental researches have helped to pave the way for the efforts of others in shop and field, and he has enjoyed their acquaintance and confidence. As a result there is found in this book a wealth of illuminating details about the work of the pioneer experimenters in aeroplane construction, seen in no other volume. The presentation seems very careful and well pondered as though the succession of attempts had been turned over and over in the author's mind during the many years of his studies.

The introduction considers the mythology of flight, beginning with a long passage of Ovid describing the flight of Daedalus and Icarus, and working into more tangible and better authenticated but still unfruitful attempts.

The first chapter opens with the work of the Montgolfiers, of Charles and Robert, with hot-air and hydrogen bags, all of which has been told and retold, of course. Then are the developments of the earliest work—the passive balloons of Green, Nadar, Coxwell, Wise. Next are given Robert's, Blanchard's, Meusnier's, Porter's Jullien's, Gifford's, de Lome's, and Renard's attempts to apply power to elongated balloons and the reader is acquainted with the features of each which have survived. We find also traced the more fruitful labors of Santos-Dumont, Julliot, Surcouf and Kapferer, Godard, Gross, Parsefal, Schwartz, and finally Zeppelin, for whom the author reserves a high place in the development of the dirigible balloon.

This completes Part I.; in Part II. the author passes over to the heavier-than-air type and starts with the noted proposals of the great artist and architect Da Vinci. How far such noted experimenters as Caley, Stringfellow, Wenham, Penaud, Hargrave, Phillips and Langley went with power-driven models is portrayed. Never before has it so well been shown how near they all were to the greater success of the present day and how small the gap between those days and ours. The bridge of the gap, of course, was the automobile motor.

From Langley the author turns back to the bird school, which approached the goal by first building unpowered gliders—Le Bris, Mouillard, Lilienthal, Pilcher, Chanute, and the Wrights. These men placed all emphasis on skillful manipulation and made designs secondary to practice. Nearly every one knows how the art and science has gone ahead since then by leaps and bounds. The author has it all recorded for our convenience, however, with types, features, dates and performances, and he has traced the descent of similar ideas through them all—a comparison that is deadly to many claims of complete originality.

The third part of the book is entitled "Aeronautic Meteorology" and here we find a treatise on the general properties of quiet air and the laws of winds and storms—as we know them.

# Modern Practice in Interurban Electric Railroad Engineering

Reviewed by C. L. DE MURALT*

ELECTRIC RAILWAY ENGINEERING—By C. Francis Harding, E. E., Professor Electrical Engineering; Director, Electrical Laboratories, Purdue University; Assoc. M. Am. Inst. E. E.; Assoc. M. Am. El. Ry. Assoc.; M. Soc. Prom. Eng. Ed. New York and London: McGraw-Hill Book Co. Cloth: 6x9½ in.; pp. 336; 138 text illustrations; 37 tables. $3, net.

The book before us is peculiar. Clearly, its title, "Electric Railway Engineering," is misleading. Under this title one would nowadays expect to find a treatise dealing with the various phases of the use of electricity as motive power on railways. The table of contents is designed to confirm this expectation. It shows the book to be divided into four main parts: (1) Principles of train operation, (2) Power generation and distribution, (3) Equipment, and (4) Types of systems, and each of these four parts is subdivided in such a manner as to intimate a very thorough and exhaustive treatment of the matter.

What the book covers, however, is really nothing but a cursory description of present-day "standard" practice in interurban electric railroad work.

Whether or not a book of this character was needed, in view of the fact that we have the subject already pretty well covered by such books as Gonzenbach, Gotshall, Herrick and others, may be left undiscussed. But that it should not have attempted to sail under false colors, and thus to have tried to place itself in a class with the two books of Sheldon and Burch, recently reviewed, is certain.

As regards the contents, similar remarks apply. The book is prepared as a text-book for an advanced university course in electric railway engineering. For this purpose it is wholly unfit. In its preface we read:

> The volume does not purpose to present any great amount of new material nor principles, but it does gather in convenient form present-day theory and practice in all important branches of electric-railway engineering.

The treatment is not only not scholarly, it is almost unscientific. To give but a few examples from among the many that can be found throughout the book. On page 22:

> In order to determine the net income it would be possible, of course, to approximate the operating expenses, fixed charges, etc., in detail, and subtract them from the gross income. A fair average income is often taken, however, as 45%.

No matter how true it may be that such methods are often employed by men with or without technical training, quite certainly this is not the proper way to present the subject to advanced students in electrical engineering. On page 243:

> A very rough and simple method quite commonly used (to select the proper motor) is to prepare a table from technical journals or the railway census of the equipments of various roads operating under as nearly as possible the same conditions as the proposed road. This table should include number and capacity of motors, average voltage, schedule speed, weight of cars, lay-over at terminals, stops per mile, average grade and, if possible, the watt-hours per ton-mile demanded. By comparison with such a table the correct standard size of motor for the new equipment may readily be determined.

Is it right to teach advanced students in this fashion? Is this not rather the direct path which leads to "catalogue" engineering? Throughout the book such terms as "standard," "custom," etc., occur again and again, and thus clearly indicate what the writer had in mind whilst he wrote.

Had the book been entitled "Modern Practice in Interurban Electric Railroading," or something similar, nobody could have found any fault with it. And had it been frankly addressed to the average railroad operating man, it would doubtless have been of value to many who wish to inform themselves on the present status of their art. For this purpose, however, it would have been better to cut out practically all of the mathematics, which, as presented, are largely superfluous, anyway.

Coming to details, it must be admitted that the author evidently knows the subject of direct-current traction, as actually practiced on interurban lines, quite thoroughly, though we find him weak on the more recent developments in alternating-current work. His historical outline of the development of electric traction in general is good, though necessarily brief. The two following chapters deal with Traffic Studies, such as would have to be made to investigate an existing road or to plan a new one. Then comes a short chapter on Train Schedules, followed by a chapter on Motor Characteristics. The comparison between series and shunt motors on page 39 and following is of doubtful value in the form presented, and it certainly leaves an entirely wrong impression on the reader. Then we have five chapters on Speed-Time Curves. Here the general tendency of the book is well exemplified. Instead of dealing with the matter in basic fashion and endeavoring to establish principles, we find the "cut-and-try" method recommended and given undue prominence. In Part II. there are eight chapters on Station-Load Curves, Distribution System, Substations, Transmission System, Power Stations, Rail Bonds, Electrolysis, and Signalling, all of these items being described largely with reference to standard direct-current practice. Some information is furnished on the single-phase alternating-current system. Three-phase practice is not mentioned. Part III. has the following chapters: Track, Rolling Stock, Motors, Motor Control, Brakes, Car Houses, Electric Locomotives. Part IV., Types of Systems, would better have been left out altogether. It contains only 27 pages, in two chapters, Alternating-Current vs. Direct-Current Traction and Electric Traction on Trunk Lines, and the author plainly has had no personal experience in this field, and therefore largely quotes other authors. His own statements in these two chapters certainly should be taken with several grains of salt.

If the above criticism is severe, be it remembered that it relates principally to form. If it is deemed advisable to bring out a second edition of this book, it is suggested that it be freed of the scientific air which it now assumes without grounds. There is much of value in the book, and if the author will take the trouble to put it into concise form it will doubtless be appreciated.

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THE IRRIGATION OF MESOPOTAMIA—By Sir W. Willcocks, K. C. M. G., F. R. G. S.; Adviser to the Turkish Ministry of Public Works, Constantinople. London: E. & F. N. Spon, Ltd. New York: Spon & Chamberlain. Cloth; 7x10½ in.; pp. 136, with portfolio containing 46 plates. Boards; 14½x16½ in. Two volumes, complete, $8, net.

Of all the work beneficial to mankind that the engineer is called upon to undertake, the development of the waste places of the earth may be classed as the most direct, and of the many deserts throughout the world, which it is possible to reclaim for agricultural purposes, the area lying north of the Persian Gulf and known as Mesopotamia is probably the most notable. Here in ages past there once was a prosperous civilization, subsisting upon products gained from ground cultivated according to methods which even today cannot be surpassed. Since the Babylonian times, however, the country has fallen into disuse and the natural development of the water which freely flows through its two rivers, the Tigris and the Euphrates, has been allowed to lapse. Recognizing the wonderful facilities of the country if properly irrigated, the Turkish government some years ago delegated Sir William Willcocks, of Indian and Egyptian engineering fame, to report upon the possibilities of irrigation along the banks of these two great rivers. This report Sir William Willcocks has just published. After a thorough investigation of the financial and engineering possibilities of the location, he has decided that under proper construction a perennial irrigation system, consisting mainly of barrages, dams and canals, similar to those now in use in the irrigation of Upper India, may be built along the Tigris and the Euphrates so as to irrigate an area of about 10,000 sq. miles, which readily can be profitably planted in grain and cotton. The entire project, as designed by him, would cost approximately $100,000,000, and would bring in

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an annual profit of about 25%, of which 9% would go to the government. He states, also, that in addition to the direct gain from the irrigation-work expenditure, the government would gain by increased import duties and all sources of revenue which accompany increased wealth among the people. The report sets forth the results of a thorough investigation of the engineering and agricultural difficulties involved and is accompanied by a large portfolio of drawings showing the construction of the various works proposed.

## Strength of Materials—Power Transmission

Reviewed by LEWIS E. MOORE*

STRENGTH OF MATERIALS—By H. E. Murdock, M. E., C. E.; Member of the Society for the Promotion of Engineering Education and of the Department of Theoretical and Applied Mechanics in the University of Illinois. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 5x7½ in.; pp. 308; 153 text illustrations; many tables. $2, net (8/6 net).

THE ELEMENTS OF THE MECHANICS OF MATERIALS AND OF POWER TRANSMISSION — By William R. King, U. S. N., Retired; Principal, Baltimore Polytechnic Institute. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 6x9¼ in.; pp. 266; 140 text illustrations. $2.50, net (10/6, net).

The first of these books is intended primarily for a text for class-room use and presents the fundamental principles of the strength of materials without the aid of the calculus. It opens with a brief statement of the kinds of materials ordinarily used where strength is required in engineering practice and of their methods of manufacture or their occurrence in nature. Direct stresses are then taken up by means of simple illustrations and accompanied by tables of the strength of various materials. Stresses in thin cylinders and spheres are treated, followed by a brief paragraph on resistance of tubes to collapse. The presentation of the methods of computing the strength of riveted joints is unusually good.

The subject of beams is taken up in about the usual way, free use being made of diagrams to explains loads, shears, etc. One feature of the diagrams which the author neglects to explain is his reason for curving load and shear diagrams at the ends. The question of moving loads and absolute maximum moment is also briefly stated. Then comes in order the finding of the internal stresses in the beam due to flexure. The author lays emphasis on the three problems which ordinarily arise in connection with beams; namely, the investigation of beams, the finding of safe loads for them and their design.

The next subject treated is that of stresses in structures, such as chimneys, dams, walls and piers. In this connection the author has given an extremely clear idea in less than half a page of the kern and what its shape is in certain cases. A chapter on graphic integration follows, giving methods of performing integration and finding the constants of integration graphically.

The elastic curve is then treated and the relations existing between load, shear, bending moment, slope and deflection curves are clearly brought out. A chapter is devoted to the treatment of special cases of beams under different kinds of loading, finding maximum moments, deflections, etc., for these cases. Overhanging, fixed and continuous beams are next taken up, the continuous beam being treated by means of the theorem of three moments.

One chapter is devoted to the finding of the elastic curve by means of the calculus, this being the only chapter in the book in which the calculus is used. The book is so arranged that this chapter may be omitted from a course without injury to a logical pursuit of the subject.

Then follow methods of finding the magnitude of unit shearing stresses at different points and the resultant of bending, shear and direct stresses. A chapter on columns follows, which is notable for its illustrations. These show with great clearness the shape taken by a column under stress with varying end conditions. Emphasis is laid upon the fact that almost all column formulas are largely empirical, and particular emphasis is laid upon the straight-line formula.

Two chapters on torsion, repeated stress, resilience, mechanical hysteresis and impact follow. The book is closed by appendixes giving the methods of finding location of centers of gravity and moments of inertia, and tables of bending moments, shears, working stresses, etc., for beams and materials.

The presentation as a whole is clear and logical, although the style of the author is in some cases a little involved. The demonstrations are entirely confined to cases of homogeneous materials.

The book is intended primarily for the class room and requires a preliminary knowledge of the elementary principles of mechanics. It is a book that can be used very advantageously for teaching this subject to classes which have not had the calculus. Its highest usefulness will be found in the class room, but it may also fill the wants of those who are engaged in practical engineering work but who have never had a course in strength of materials.

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The second of the two books before us is divided into two parts, both included in one binding. To quote from the preface:

> Part I is devoted to the elements of the Mechanics of Materials, and Part II to the elements of power transmission. It has been the aim to present both subjects only to the extent that will impart such a working knowledge of the fundamentals as will enable the student to grasp more extended works without aid.

A knowledge of the calculus is requisite to an understanding of the demonstrations.

The first 217 pages of this book are devoted to the strength of materials, and the last 39 pages to the elements of power transmission. The author begins with the center of gravity, moment of inertia and radius of gyration, taking up then bending moment and shear diagrams, the theory and designs of beams, the designs of columns and shafts, internal work and resilence. This occupies 113 pages. Graphic statics, together with some of its applications to framed structures, occupy the next 70 pages. A chapter is then devoted to engineering materials and another to testing materials.

The second part, the elements of power transmission, is practically confined to the transmission of power by means of belts, ropes, and toothed wheels. The strength of belting is also taken up, but not the strength of gearing, the portion on gearing being confined almost exclusively to figuring velocity ratios and tangential pressures in toothed gearing.

The book is one that is evidently written having in mind the needs of a particular class in a certain institution. More emphasis is laid upon how to work problems out than upon the fundamental principles. There do not appear to be any serious errors in the book, although the author is at times careless in the use of words. An instance of this is the statement in the definition of a column that it is a straight *beam* acted upon compressively at its extremities. Considered from the standpoint of what a book on the strength of materials should be, the different parts are not given their proper relative emphasis. The book is one which will undoubtedly fill the needs of the author's own class but is hardly one that will be adopted in other institutions to any extent.

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A COMPARATIVE STUDY OF WAGE AND BONUS SYSTEMS—The Emerson Co., 30 Church St., New York City. Paper; 5x8 in.; pp. 27; illustrated.

One of the foundation principles of the methods of increasing the efficiency of labor, which are now attracting so much attention, is the payment of increased wages to employees who produce more than the average amount of work. There are a number of rival systems which adopt different plans for apportioning this increased compensation to the employees. The pamphlet before us describes the Emerson "bonus" system originated by Mr. Harrison Emerson and explains the features in which it differs from other systems of paying labor.

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# A New German Pocket-Book for Civil Engineers

Reviewed by F. C. KUNZ*

TASCHENBUCH FUER BAUINGENIEURE—Herausgegeben von Max Foerster, ord. Professor an der Technischen Hochschule in Dresden. Berlin: Verlag von Julius Springer. Cloth; 5x8 in.; pp. 1912; 2723 text figures. Marks, 20; American price, $8, net.

It may be a surprise to many engineers to see another volume added to the present great number of German pocket-books on engineering subjects. However, while most of them are either devoted to a certain branch of civil engineering only, or treat this subject among others too briefly, the present book covers the whole field of civil engineering in a concise but thorough and comprehensive manner and on a scientific basis. It will, therefore, be found of great value both as a text-book for the advanced student and as a manual for the practicing engineering.

This work contains the main subjects of civil engineering (statics, materials of construction, surveying, bridges, hydraulic engineering, roads, tunnels, etc.), with their subsidiary branches (mathematics and mechanics) and also a number of other technical subjects with which the civil engineer may have to make himself acquainted, such as buildings, mechanical engineering, electrotechnics. As a special evidence of the wide scope of the book may be mentioned a brief exposition of the aesthetic principles of city planning and a treatise on jurisprudence.

This book is comparable with the well-known and probably most popular German pocket-book "Hütte." While the "Hütte" is wider in scope, embracing practically all engineering sciences, Foerster's book will prove of greater value to the civil engineer in particular.

The different chapters are complete treatises by themselves and have been written by authorities on the respective subjects. The text is arranged in a lucid manner and accompanied by many excellent illustrations, for which much credit is due to the publisher.

The title "pocket-book" should not be taken, literally, for, as may be judged from the voluminous contents, the book is rather bulky, being 2½ in. thick and containing 1900 pages. A division into two separate volumes would have decidedly benefited users of the book and it is to be hoped that this will be done in a future edition.

The first chapter, by F. Kögler, is principally a compilation of mathematical formulas and problems and contains also tables of squares, logarithms, etc. The second chapter, on mechanics, by the same author, gives the principal elements and laws of statics, dynamics and hydrostatics.

The next four chapters are by Prof. G. Mehrtens, the well-known authority on bridge building. They summarize graphic statics, strength and elasticity of materials, analysis of stresses and deformations of girders and trusses, both statically determinate and indeterminate, and the calculation of masonry arches and retaining walls. As an unusual subject may be mentioned the analysis of stresses in non-planar frames; special mention may be made of the thorough treatment of elastic deformations, including the work of deformation. These chapters are in fact a condensation of the author's book "Statik und Festigkeitslehre," which is considered as one of the most complete books on these subjects, containing everything of value concerning the theories of external and internal forces in framed structures.

Then follows a chapter by Prof. M. Foerster on the theory of steel concrete, giving the methods of calculation of reinforced beams and columns now generally adopted; the numerous well-selected examples greatly increase the practical value of this chapter. Another chapter by the same author, on materials of construction, gives the strength, elasticity and other qualities of the more important building materials; attention is called to the great amount of information concerning natural and artificial stones.

After a chapter by A. Schrieber on surveying, describing the various instruments and methods, follow two chapters on the design and detailing of buildings; the first, by Prof. Th. Böhm, treats the timber and masonry constructions, while the second, by Prof. M. Foerster, is devoted entirely to steelwork. Both chapters are characterized by a clear description and illustration of numerous details.

A chapter on hydraulic engineering, by Prof. H. Engels, explains the different methods of foundation, the design of quay walls, dams, locks, the flow of water, correction of rivers and gives general data on the design of canals, power plants, maritime construction, etc.

Three short chapters by F. Kögler review the design of wooden, masonry and steel concrete bridges. Considerable space is devoted in another chapter, by Prof. G. Mehrtens, to the design of steel bridges, including considerable data on external forces, with tables of weights and the more important details, from the simple plate girder to the chains and cables of suspension bridges.

In a chapter about road building Prof. G. Lucas explains the methods of earth excavation and transportation, the design and construction of tunnels, street and railroads, the maintenance and operation of railroads, etc., considerable space being given to the signals and safety appliances. Two chapters by Th. Koehn treat the water supply and sanitation of cities, including the design of reservoirs, filtration plants, sewers, settling basins, etc.

Finally follow three accessory chapters on aesthetic principles of city planning, mechanical engineering (particularly building machinery) and jurisprudence.

Although the text will be out of reach to those engineers who have not mastered the German language, the illustrations and formulas are so clear and complete that the book will prove of value to any American engineer who wants to keep informed of the progress of engineering science in Europe.

THE PRACTICAL GAS AND OIL ENGINE HANDBOOK—A Manual of Useful Information on the Care, Maintenance and Repair of Gases and Oil Engines. By L. Elliott Brookes, Author of "Construction of a Gasoline Motor," and "The Automobile Hand-Book." Chicago, Ill.: Frederick J. Drake & Co. Stiff morocco; 4½x6¾ in.; pp. 192; 50 text figures. $1, net; leather, $1.50.

The information contained in this book applies chiefly to automobile and motor-boat engines, and for this reason it would be hard to justify the title of "Practical Gas and Oil Engine Handbook." In the comparatively few instances where the author attempts to give information on other types of engines, the result is generally of somewhat doubtful value. As, for example, in the directions for starting a gas engine, the reader is instructed to first close the battery switch, next open the gas valve, so as to admit a charge of gas into the inlet-valve chamber, and then to "give the flywheel four or five quick turns until the engine starts." The instructions for computing the mean effective pressure from an indicator diagram, given on pp. 74 and 75, are of such a nature as to suggest that the author was merely working to obtain what he had found to be the correct answer rather than following out any analytical process of reasoning in explaining the computation.

The book is arranged as a series of paragraphs or sections with black-faced headings, resembling in this particular the various automobile handbooks by the same author. The sections are alphabetically arranged according to their subjects. The book is comparatively free from typographical errors, but some of those which do occur are rather baffling; for example, on p. 160 we read, "Some gas engines are fitted at the wrist-pin and journal bearings with grease cups which should be filled with shafting and set so as to feed automatically." An appendix at the back of the book contains miscellaneous items apparently "received too late for classification." The description of a certain type of spark plug, which occupies the last five pages of the appendix, has a certain commercial twang. It states, for example, that this plug is far superior to any closed plug on the market, and a reference further on to "our" multiple-point sparking gap sug-

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gests that this matter was rather hastily edited from some trade catalog.

Apart from its misleading title and in so far as it applies to automobile and motor-boat engines, the book as a whole is commendable.

## A New Edition of Peabody's Naval Architecture

REVIEWED BY D. W. TAYLOR*

NAVAL ARCHITECTURE—By Cecil H. Peabody, Professor of Naval Architecture and Marine Engineering, Massachusetts Institute of Technology. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 6x9¼ in.; pp. 641; 218 text illustrations. $7.50, net (31s. net).

The first edition of this book appeared in 1904 and was very favorably reviewed at some length in this supplement on April 14, 1904.

In this revised edition the changes that have been made are all in Chapters X, XI and XII, dealing, respectively, with the resistance of ships, the propulsion of ships, and power for ships. There are many omissions and additions from p. 395 to p. 452, and there are 16 new tables inserted at the end, which deal mainly with propellers.

There is practically no change in size, there being 610 pages of text in the new edition as against 608 pages in the first edition. The chapters which are not changed deal with calculations, stability and allied subjects, launching, waves, rolling, steering and maneuvering, and weight and strength.

The portions of the book which have been rewritten cover questions of resistance and propulsion somewhat more simply and certainly than before, mainly by taking advantage of the results of numerous experimental researches which have been published since 1904. In the chapter upon resistance of ships, the principal new matter deals with stream lines around ships, resistance in shallow water and resistance due to appendages. Two new diagrams showing lines of flow around two types of vessels are given, but the description of this flow does not agree with the diagrams.

The author proposes a standard form of propeller blade such that the contour viewed from aft is mainly that of an ellipse tangent to the hub. To obtain the necessary length of blade at the hub, however, the contour in this vicinity is obtained by drawing lines from the shaft axis tangent to the ellipse. This proposed standard blade is not put forward as possessing particular merit of efficiency from its shape, but simply as a convenient type to use, which it undoubtedly is.

Very complete tables of coefficients and constants are given for use in connection with propeller design. These are based mainly upon published results of experiments at the United States Model Basin, but the author points out that these results are in close agreement with those published by R. E. Froude from experiments in England. The new matter in the chapter on the power of ships is mainly of somewhat minor importance.

This book covers fully the very excellent course in naval architecture conducted by Professor Peabody. As a general textbook for the student it is believed to be distinctly superior to any other book on its subject in the English language.

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THE ORIGIN AND PREVALENCE OF TYPHOID FEVER IN THE DISTRICT OF COLUMBIA (1909-1910)—By L. L. Lumsden and John F. Anderson (including articles contributed by Thomas B. McClintic and Wade H. Frost). Bulletin No. 78, Hygienic Laboratory, Treasury Department, Public Health and Marine-Hospital Service of the United States; Report No. 4, October, 1911. Washington, D. C.: Pub. Doc. Paper; 5⅝x9 in.; pp. 196; 15 maps and 27 charts.

This report, which is the fourth in a valuable series, seems to completely vindicate the water filtration plant of Washington from any direct or implied charges against its sanitary efficiency, based on the continued high rate of typhoid fever in Washington after the plant was put in use, a half dozen years ago. (It may be interjected, that typhoid has materially declined of late.) Very briefly stated, the conclusions of the present report are that "the greater part of the typhoid-fever infection in Washington is distributed through milk, green vegetables, and other foods, and by fingers and flies;" and that "since the autumn of 1906 the public water-supply has played a relatively small part, if any, in the causation of typhoid fever in Washington." It will be noted that this leaves some question as to the part played by the water-supply during the first few months after the filters were put in use, but without stating whether this might have been due to infection in the mains dating from before the filters were started.

The character of the studies made during the period covered by the present report is stated in the Introduction as follows:

> The studies made in the fourth year (1909) of the investigation comprised an epidemiological study in detail of all cases reported to the health office during the whole calendar year; systematic bacteriological examinations of water from (1) the Potomac River as the water entered the first of the series of sedimentation reservoirs in operation (either Dalecarlia or Georgetown), (2) the effluent from the last of the series of sedimentation reservoirs (Washington City) representing the water applied to the filtration beds, (3) the effluent from the storage reservoir for the filtered water just as it entered the conduits for distribution to the city, and (4) different taps in the city; a clinical and laboratory study of about 100 cases reported as typhoid fever to determine the percentage of error in diagnosis; bacteriological examinations of specimens of feces and urine from about 300 persons who had had typhoid fever within the ten years previous, to determine the proportion of bacillus carriers among persons in the District of Columbia recovered from typhoid fever; and a particular study of general food supplies, of sanitary conditions, and of all other conditions thought to be likely to have any bearing on the immediate situation.

The studies in 1909 were more complete than those made in the previous years, inasmuch as they were continued throughout the whole calendar year instead of during the typhoid season (May 1 to November 1) only, and in this report most of the data are presented in a way to show whatever difference there were seasonally in the various conditions.

In all four of the years, 1906-9, the epidemiological data about individual cases of the disease were collected by the same members of the board, and consequently difference in findings for any two of the years may be attributed to differences in conditions, since the factor of personal equation has not varied.

We have endeavored to make the investigation progressive, the findings of one year serving to indicate further research along certain lines in subsequent years also for comparison with the findings of all the other years. In the text and in many of the tables and charts of this report comparable data collected for the different years are given; and the conclusions presented in this report have been drawn from a consideration of all the data about the typhoid fever situation in Washington which have been collected by this board in the course of the whole inquiry covering a period of five years (1906 to 1911).

As we have already said, this report is one of a valuable series. It seems particularly fitting that such a long-continued study should be made of typhoid conditions of the seat of our federal government, and subsequently published for the benefit of the whole country.

INSPECTION OF THE MATERIALS AND WORKMANSHIP EMPLOYED IN CONSTRUCTION—A Reference Book for the Use of Inspectors, Superintendents and Others Engaged in the Construction of Public and Private Works. Containing a Collection of Memoranda Pertaining to the Duty of Inspectors; Quality and Defects of Materials; Requisites for Good Construction; Methods of Slighting Work, Etc. By Austin T. Byrne, Civil Engineer; Author of "Highway Construction." Third edition, thoroughly revised. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 4¼x7¼ in.; pp. 609. $3, net.

The cover title, "Inspector's Pocket-book," by which the well known work by Austin T. Byrne is generally called, does not convey as complete an understanding of its contents as does the full title, given above. Since the publication of its first edition, some twenty years ago, this work has supplied a want not adequately filled by any other book. Not only is it a guide to inspectors on all kinds of construction work, but it is a compendium of information regarding structural material, which presents in tabular and other form quite all the data regarding material necessary to the designer as well as the constructor. The second edition, published in 1902, and the third edition, just issued, each brought the information up to date, although the general form is of such a nature as not to require any considerable change in the various editions.

## Books and Reports on Cement and Concrete

PORTLAND CEMENT—Its Composition, Raw Materials, Manufacture, Testing and Analysis. By Richard K. Meade, M. S.; General Manager of The Tidewater Portland Cement Co., Formerly Chemist to The Dexter Portland Cement Co., The Edison Portland Cement Co., and The Northampton Portland Cement Co.; Author of "The Chemists' Pocket Manual," etc. Second edition. Easton, Pa.: The Chemical Publishing Co. London: Williams & Norgate (14 Henrietta St., Covent Garden, W. C.). Cloth; 6x9 in.; pp. 512; 169 text illustrations; 53 tables. $4.50, net.

The first edition of Mr. Meade's book, practically the only one in American literature covering this subject as completely as it does, was published about five years ago, and was reviewed in this journal on Jan. 17, 1907. This second edition has been revised to a considerable extent. The developments of the last five years have been included so that the section on manufacture has been increased about 76 pages. The section on analytical methods has been somewhat similarly increased, and the section on physical testing has been revised to conform to the changes made in the standard specifications and methods of testing. Beside these revisions, a new chapter on the investigation of materials for the manufacture of portland cement is included, and the number of illustrations have been increased from 100 to 170. In the chapter on the nature and composition of portland cement, the research work, undertaken by the Carnegie Institution at Washington under the direction of Dr. E. S. Shepherd, is given full space so that the somewhat indeterminate subject of the composition of cement is at least brought down to the latest knowledge concerning it. As a textbook for manufacturers of portland cement, Mr. Meade's book must still remain the best in the English language.

FACTORIES AND WAREHOUSES OF CONCRETE—Published by the Association of American Portland Cement Manufacturers, Land Title Bldg., Philadelphia, Penn. (Percy H. Wilson, Secy.). Stiff paper; 6x9 in.; pp. 223; many illustrations. 50c., net.

The preface of this book well states its intention, as follows:

> The purpose of this book is to present to those intending to build industrial buildings a few examples, of the many hundreds in this country, of factories and warehouses of reinforced-concrete construction and to give important facts concerning these buildings. . . . There are 235 buildings shown, which house 198 industries. Thirty states are represented, as is also the work of 132 architects, 193 engineers and 97 contractors. . . . The book is arranged in groups of four pages. On the first of the four pages is a typical example of a building at a certain class of occupancy, and on the second page follows a description of this example, giving facts of interest to a prospective builder. On the third page appears an interior view, together with a letter from the owner of the building. On the fourth page there is a group of photographs and buildings used for similar purposes.

Considerable skill has been shown in collecting the various examples illustrated and the typographic make-up is excellent. Owners contemplating the erection of factory buildings would certainly do well to look over this publication.

CEMENT PIPE AND TILE—Advantages of Cement for Pipe and Tile, Methods of Manufacture, Tests, Costs, Etc. By E. S. Hanson, Editor "The Cement Era." Second edition. Chicago, Ill.: The Cement Era Publishing Co. Cloth; 5x7¾ in.; pp. 153; one folding plate and many text illustrations. $1, net.

When the first edition of this book was written, some three years ago, the cement pipe and tile industry was only in its beginning. It is strange, therefore, that the new edition should be called for. This latest edition takes up the subject where the other left off and records the present stage of the industry. The author says it will be probably necessary in the future to issue new editions from time to time, as the methods of making cement pipe approach perfection.

PRACTICAL CEMENT WORK—An Elementary Treatise on Cement Construction. By W. B. Henry. Atlanta, Ga.: The Concrete Age Publishing Co. Linen; 4x6½ in.; pp. 110, 50c., net.

There are any number of practical mechanics versed in brick and stone masonry who wish to obtain a working knowledge of the use of cement and concrete. For such men the little book by Mr. Henry would be very useful. It claims to know technical superiority, but is directed entirely toward the practical man who wishes to keep uptodate in his trade.

EXPERIMENTS IN STRENGTH OF MATERIALS AND CEMENT LABORATORY—By Earl B. Smith, M. E.; Assistant Professor of Experimental Mechanical Engineering, Drexel Institute, Philadelphia, Penn. Paper; 6x8¾ in.; pp. 24. Address The Author.

This little pamphlet contains a synopsis of tests and instructions to students for use in a strength of materials testing laboratory. The tests include the ordinary testing-machine experiments and those of a cement laboratory. Professor Smith is connected with Drexel Institute in Philadelphia, so it is to be presumed that the experience there gained has been applied to the writing of this pamphlet.

The American Society of Civil Engineers makes a notable innovation in form of publication, beginning with the new year. Its "Transactions" will hereafter be printed on thin India or Bible paper, so as to reduce the bulk of the year's total, and by virtue of this change it is expected to be possible to bind the full year's issue in one volume. For many years past the "Transactions" appeared in two volumes, June and December. A few years ago, however, the increased bulk of matter made it necessary to issue four quarterly volumes, which practice has continued without change except that in 1910 two extra volumes were necessary—making six for the year—to accommodate the great series of Pennsylvania tunnel and terminal articles. A single year's issue made an aggregate thickness of 5 or 6 in., even in paper binding. This meant many inconveniences for the recipient. At the same time the handling and forwarding costs increased in a way which made itself felt even in the ample financial resources of the society. The change was devised to benefit both the office and the members.

Lead poisoning occupies the greater portion of the Bulletin of the Bureau of Labor, U. S. Department of Commerce and Labor, for July, 1911 (which came out nearly six months late). Sir Thomas Oliver contributes a paper entitled "Industrial Lead Poisoning; Descriptions of Lead Processes in Certain Industries in Great Britain and the Western States of Europe." A second paper, entitled "White Lead Industry in the United States, with an Appendix on the Lead Oxide Industry," is contributed by Alex Hamilton. "Deaths from Industrial Lead Poisoning (actually reported) in New York State in 1909 and 1910" is the subject of a paper by John D. Andrews.

Besides the 282 pages on lead poisoning, the Bulletin contains laws enacted during the year 1911, requiring the report of occupational diseases. The States enacting this legislation were California, Connecticut, Illinois, Michigan, New York and Wisconsin. The legislation was secured largely through the activity of the American Association for Labor Legislation. Bills introduced in Pennsylvania and Minnesota failed of enactment. The laws require physicians to report all cases of occupational diseases occurring in their practice. Abstracts of court decisions affecting labor in various parts of the country are also given in the Bulletin.

Information for manufacturers and merchants regarding newspapers and trade papers in foreign countries suitable for advertising purposes is to be issued at intervals by the Bureau of Manufactures, Department of Commerce and Labor, Washington, D. C. The information will be in the nature of a series of reports by American Consular officers. These reports will give information regarding the location and class of paper, district covered, circulation, subscription price, and advertising rates. The list for England appeared in "Daily Consular and Trade Reports" for Nov. 27, 1911. Lists for South American countries are in course of preparation. When completed the series will cover all foreign countries.

A unique plan for hillside dwellings for working men, to be located on hillsides having a grade of 50%, is the subject of the November *Civic Bulletin*, published by the Pittsburg Civic Commission, Keystone Building, Pittsburg, Penn. The houses would be located on streets of 6 to 8% grade running up hill in what might be termed diagonal fashion and forming a series of terraces.

## PUBLICATIONS RECEIVED

[So far as possible the name of each publisher of books or pamphlets listed in these columns is given in each entry. If the book or pamphlet is for sale and the price is known by the editor the price is stated in each entry. Where no price is given it does not necessarily follow that the book or pamphlet can be obtained without cost. Many, but not all, of the pamphlets, however, can be secured without cost, at least by inclosing postage. The amount of postage necessary can be estimated approximately from the stated size of the book or pamphlet and the number of pages it contains. Reprints of papers read before engineering societies and printed by the authors for private circulation can often be obtained without cost by addressing the author, whose name and address is always given when known. Persons who are in doubt as to the means to be pursued to obtain copies of the publications listed in these columns should apply for information to the stated publisher, or in case of a reprint of a society paper to the author of the paper. The stated American prices of foreign books are based on 40 cents per shilling and per mark for British and German books, respectively, and 30 cents per franc for French books, the extra allowances being for importation costs.]

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION (INCORPORATED)—Report of the Proceedings of the Annual Convention Held at Atlantic City, N. J., June 14-16, 1911. Chicago, Ill.: The Association (Secy., Jos. W. Taylor, 390 Old Colony Bldg.) Cloth; 6x9 in.; pp. 516; many folding and other plates.

THE AUTOBIOGRAPHY OF JOHN FRITZ—New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 6¼x9¼ in.; pp. 327; 21 text illustrations. $2, net (8/6 net).

DER BAU DES PANAMAKANALS—Vortrag Gehalten im Ministerium der Oeffentlichen Arbeiten in Berlin. Von Eugen Tincauzer, Geheimer Baurat. Berlin: Wilhelm Ernst & Sohn. Paper; 7x10 in.; pp. 44; 44 text illustrations. Marks 1.40, net; American price, 56c., net.

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